Research report on

Building Capacity for anti-drug sector and healthcare sector in the use of different physical exercise modalities for treatment and rehabilitation

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Executive Summary

Introduction

1. Physical exercise modalities have always been used as a tool, along with other treatment methods, in drug treatment and rehabilitation services.

2. While there is no controversy regarding the role of physical exercise as an adjunct treatment modality in helping drug-dependent populations in treatment and rehabilitation, recruitment and adherence to physical exercise interventions has always been an issue. Research has pointed out that subjective exercise experience during treatment and rehabilitation is crucial.

3. No integrative synthesis, combining quantitative and qualitative evidence, has been conducted to generate a comprehensive understanding of the exercise experiences of the drug-dependent population all over the world. There is a need for drug treatment and rehabilitation service providers in Hong Kong to be informed by literature that examines both the objective effects and subjective experiences of the drug-dependent population when they participate in a physical exercise intervention as treatment and rehabilitation modality.

Identification of physical exercise intervention for drug-dependent group from the literature

4. Majority of the physical exercise interventions were conducted in China, followed by the United States. The majority of the interventions adopted a co-gender approach, with less than 30% of the studies adopting a gender-specific approach.

5. For the young adult group, the top three most frequently investigated physical exercises types were 1) aerobic exercise; 2) mind-body exercise; and 3) structured fitness training.

6. For the female group, the top three were 1) mind-body exercise; 2) aerobic exercise and 3) movement therapy.

Identification of existing outcome measures for use in the evaluation of physical exercise intervention for drug-dependent group in the literature by narrative description methodology

7. The literature review identified a total of 62 outcomes and 184 related instruments used to evaluate physical exercise interventions for the drug-dependent group.

8. The interdisciplinary scientific committee categorize these outcomes into ten major outcomes. They are a) physical and physiological outcomes; b) behavioural outcomes; c) clinical or health outcomes; d) neurological or cognitive outcomes; e) psychological outcomes; f) sleep outcomes; g) substance-use outcomes; h) quality of life outcomes; i) social outcomes and j) multi-dimensional outcomes.

Systematic synthesis of the effectiveness of different types of physical exercise intervention for different drug-dependent groups (i.e., young adult and female) using meta-analysis methodology

9. Mind-body exercise, aerobic exercise and structured fitness training are the three major types of physical exercise consistently found to be significantly more effective than control groups in improving outcomes in the ten major domains.

10. For female drug-dependent subgroup, mind-body exercise was consistently better than control in improving both quality of life and flexibility outcomes.

11. For young adult drug-dependent subgroup, structured fitness, aerobic exercise, mind-body exercise and mixture of leisure activities and exercise are the four major types of physical exercise consistently found to be significantly more effective than control groups in improving several outcomes.

Qualitative synthesis of the recurring themes related to the subjective experiences of physical exercise intervention among the drug-dependent groups

12. Ten major themes emerged as unique benefits of exercise and sports intervention for the drug-dependent groups. They are, “distraction”, “expressing true self”, “attaining a different kind of euphoria”, “establishing courage to face challenges”, “found new purpose in life”, “establishing a disciplined lifestyle”, “improved communication skills”, “engaging with a supportive social network”, “having a supportive social space”, and “re-engaging with community”.

Recommendations

For practitioner

13. Exercise prescription to the drug-dependent group or subgroup should base on updated scientific evidence. For instance, practitioners' decision of choosing a particular type of physical exercise modalities in influencing certain outcomes should be based on the results from meta-analyses presented in this report (i.e., effect size). Apart from effect size, practitioners may also consider the subject experience of the drug-dependent population in exercise participation through qualitative studies as documented in the literature.

14. Based on the integrative synthesis, to facilitate drug addicts to re-integrate into community, non-government organisations should set up physical/virtual social space and network that facilitate drug-dependent group to continuously engage in physical exercise with enhanced social support.

For researcher

15. Qualitative study on how the drug dependent group perceive physical exercise as treatment modality in their recovery trajectory is absent among the Chinese population. Future experiments conducted in Hong Kong should consider mix-method study that capture data that cannot be measured quantitatively.

16. All qualitative studies found focused on the young adult group, and not even one qualitative study investigates how female or mother drug addicts apply physical exercise modality in the rehabilitation process and how physical exercise play a role in the recovery and community reintegration process. Future qualitative study should focus on female and the mother sub-group.

研究摘要

簡介

1. 在戒毒治療和復康服務中，體育運動干預一直是其中一種有效的輔助治療方法。

2. 雖然體育運動干預作為輔助治療方式在幫助藥物依賴群組治療和康復方面的效用並沒有爭議，但體育運動干預的招募和對計劃的依從性卻是一個問題。 研究指出，治療和復康過程中的主觀體育運動體驗至關重要。

3. 綜合全世界的文獻我們未曾結合定量和定性的研究證據作綜合性分析，以更全面地了解藥物依賴群組參與體育運動干預作為治療和康復的體驗。 香港的戒毒治療和復康服務提供者需要參考文獻，以更全面地了解藥物依賴群組在參與體育運動作為治療和康復方式時的客觀效用和主觀體驗。

從文獻中識別的體育運動干預

4. 大部分體育運動干預實驗是在中國進行的，其次是美國。 大多數干預沒有分開男女來進行，只有不到 30% 的干預性研究分析了只給男性藥物依賴群組的體育運動干預或只給女性藥物依賴群組的體育運動干預。

5. 對於青壯年組，最常被調研的頭三種體育運動類型分別是：1）有氧運動； 2）身心運動； 3）健身訓練。

6. 對於女性組，最常被調研的頭三種體育運動類型分別是：1）身心運動； 2）有氧運動和 3）動態療法。

以敘述性描述方法從文獻中識別體育運動干預效能指標

7. 文獻回顧共識別了 62 個體育運動干預效能**指標**和 184 個相關的調研工具。

8. 跨學科科學委員會將這些效能分為十大領域。 它們是 a）身體和生理效能； b）行為效能； c）臨床或健康效能； d）神經或認知效能； e）心理效能； f）睡眠效能； g）藥物使用效能； h）生活品質效能； i）社會效能和 j）多維度效能。

以統合分析系統性地綜合不同類型體育運動干預對不同藥物依賴群組（即青壯年人和女性）的有效性

9. 身心運動、有氧運動和健身訓練是在改善十個主要領域的效能方面，其效果比對照組顯著更有效的三個主要類型。

10. 對於女性藥物依賴群組，身心運動在改善生活品質和柔軟性效能方面優於對照組。

11. 對於青壯年人藥物依賴群組，健身訓練、有氧運動、身心運動以及休閒活動是比對照組在改善多項結果方面比對照組顯著更有效的四個主要類型。

藥物依賴群組對體育運動干預的主觀體驗

12. 藥物依賴群組參與體育運動或體育運動干預的體驗可以分為十大質性主題。 它們是:“分散注意力”，“表達真我”，“獲得不一樣的興奮感覺”，“建立面對挑戰的勇氣”，“找到生活的新目標”，“建立有紀律的生活方式”，“提高溝通技巧”，“參與具支持性的社交網絡”、“擁有被支持的社交空間”和“重新參與社區”。

建議

業界

13. 對藥物依賴群組或亞群組的體育運動處方應基於最新的科學證據。例如，業界在決定以什麼體育運動干預改善特定效能的時候，應該參考本報告的統合分析的數據（例如：效應值數據）。除了效應值數據，業界亦可參考本報告整合的質性研究整合數據以了解藥物依賴群組的主觀運動體驗。

14. 綜合分析顯示，針對協助藥物依賴群組重新融入社區，非政府組織應設立實體/虛擬的社會空間和網絡以促進藥物依賴群組在社會支持下持續進行體育運動鍛煉。

學者

15. 藥物依賴群組的體育運動鍛煉定性研究缺乏中國人群的數據。 未來在香港進行的實驗應考慮採用混合方法研究，以獲得定性數據。

16. 文獻上所有定性研究都集中研究青壯年人群組，沒有一篇定性研究調查女性或母親吸毒者如何在康復過程中應用體育運動或體育運動鍛煉如何在康復和重返社區過程中發揮作用。 未來的定性研究應關注女性和母親群組。

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1. Introduction

Physical exercise modalities have always been used as a tool, along with other treatment methods, in drug treatment and rehabilitation services. Current evidence from systematic reviews and meta-analyses provides support for the use of exercise as a primary intervention or as adjunctive treatment, showing that it can improve outcomes such as anxiety (Cui et al., 2022; Giménez-Meseguer et al., 2020; Liu et al., 2020; Morris et al., 2018; Walia et al., 2021; Wang et al., 2014), depression (Cui et al., 2022; Giménez-Meseguer et al., 2020; Morris et al., 2018; Wang et al., 2014), quality of life (Cui et al., 2022; Giménez-Meseguer et al., 2020; Morris et al., 2018), abstinence rate (AshaRani et al., 2020; Giménez-Meseguer et al., 2020; Wang et al., 2014), craving (AshaRani et al., 2020; Giménez-Meseguer et al., 2020), reduction in substance use (AshaRani et al., 2020; Walia et al., 2021), improvement in fitness (Jake-Schoffman et al., 2020; Morris et al., 2018), emotions regulation (Park et al., 2018; Posadzki et al., 2014), cognitive flexibility (Brooks et al., 2020) and reduction of withdrawal symptoms (Wang et al., 2014) among the drug-dependent population.

Regarding the differential effects of the type of exercise on treatment and rehabilitation-related outcomes, a meta-analysis that performed a sub-group analysis comparing different types of exercise interventions found that mind-body exercises and aerobic exercises induce similar beneficial effects on abstinence rate, withdrawal symptoms, anxiety, and depression levels among individuals with substance use disorder. Overall, exercise intervention, regardless of whether it is aerobic or non-mindful exercise, can effectively assist individuals in withdrawing from addictive drugs (Wang et al., 2014).

Regarding the better type of physical exercise modalities to be offered to the drug-dependent population, meta-analyses have shown that both mind-body exercise and aerobic exercises, or a combination of aerobic exercise and strength training, produce similar benefits.

There is no strong evidence indicating that one was superior to the others in quantitative studies (Giménez-Meseguer et al., 2020; Wang et al., 2014). In terms of exercise intensity, a meta-analysis suggests that moderate and high-intensity aerobic exercise, designed according to the Guidelines of the American College of Sports Medicine, can produce effective and long-lasting treatment effects for drug-dependent populations.

While there is no controversy regarding the role of physical exercise as an adjunct treatment modality in helping drug-dependent populations in treatment and rehabilitation, recruitment and adherence to physical exercise interventions has always been an issue (Linke & Ussher, 2015; Weinstock et al., 2017). Research has pointed out that subjective exercise experience during substance use disorder treatment is crucial. An observational study found that participants in an exercise program offered in a drug treatment service had higher efficacy in relapse prevention, self-esteem, and perceived physical health when they enjoyed the exercise more (Furzer et al., 2021). Qualitative studies investigating participants' exercise experiences revealed that enjoyment and positive recovery experiences are the key factors in staying active or adhering to exercise programmes during treatment (Dai et al., 2020; Neale et al., 2012).

All meta-analyses and systematic reviews in the literature evaluating the use of physical exercise modalities in a drug-dependent group focused only on which types of physical exercise modalities, intensity, and frequency provide the most benefits for health outcomes related to the drug-dependent population. No integrative synthesis, combining quantitative and qualitative evidence, has been conducted to generate a comprehensive understanding of the exercise experiences of the drug-dependent population. There is a need for drug treatment and rehabilitation service providers in Hong Kong to be informed by literature that examines both the objective effects and subjective experiences of the drug-dependent population when they

participate in physical exercise interventions. Service providers should be aware of the role of sport and exercise in the rehabilitation and recovery process of the drug-dependent population.

In addition to understanding the subjective experiences of the drug-dependent groups, service providers in Hong Kong should also be aware of which physical exercise modalities might be more beneficial for special subgroups, such as young adult or females, and which group has better adherence to certain physical exercise modalities. There is a need to conduct a system review that addresses research questions relevant to Hong Kong's situation and is useful for practitioners.

1.1 About this report

The overall aim of this report is to provide drug treatment and rehabilitation service providers in Hong Kong with updated scientific evidence regarding physical exercise interventions delivered for drug-dependent populations in the treatment and rehabilitation settings, as documented in the literature. In order to address specific areas of focus outlined by the Beat Drugs Fund, this report will also perform an in-depth analysis on two major sub-groups: 1) young drug-dependent group aged 21-35 years; and 2) female drug abusers to facilitate more effective intervention. The updated synthesis will have practical implications for the sector that currently offers physical exercise classes as an adjunct therapy to their treatment and rehabilitation programmes or for those planning to offer physical exercise classes in the future.

1.2 Objectives

1) To identify physical exercise intervention for drug-dependent group from the literature
2) To identify existing outcome measures for use in the evaluation of physical exercise intervention for drug-dependent group in the current literature
3) To systematically synthesize the effectiveness of different types of physical exercise intervention for different drug-dependent groups (i.e., young adult/ female group (mother) in the literature
4) To synthesize recurring themes related to the subjective experiences of physical exercise intervention among drug-dependent group(s)

2. Methods

2.1 Search strategies

A four-stage search was conducted to enhance the comprehensiveness. The first search was conducted in September 2022. The search was conducted in the following five databases: Cumulative Index to Nursing and Allied Health Literature (CINHAL) (Ebsco), MEDLINE (Ovid), Web of Science, Scopus, and China National Knowledge Infrastructure (CNKI). The databases were searched from inception to September 2022 to ensure that all new studies were captured during the review. A combination of keywords "yoga, qigong, tai chi, physical activity, physical exercise, aerobic exercise, resistance training, weight training, addiction, substance abuse, substance use disorder, relapse, prevention" were used as keywords to search. After the first search, an experienced research librarian was consulted to review and continually improve the search strategy in light of the study questions. In the second stage of the search, one more database, "Physiotherapy Evidence Database (PEDro)" was added to improve the comprehensiveness of the search. A list of refined search terms according to Medical Subject Headings (MeSH) terms and keywords were tailored in each database in the second search. In the third stage of the search, the reference lists of all identified literature were manually reviewed to determine additional sources. A complete search strategy can be found in Appendix 1. Stage four search was conducted in mid-January 2023 with a specific focus on the "mother" drug-dependent subgroup to ensure that all target populations were included in this review. A detailed search strategy can be found in Appendix 3.

2.2 Selection of studies

Studies were included if the following are included: 1) examined the effects of physical exercise modalities (i.e., yoga, qigong, tai chi, physical activity, physical exercise, aerobic exercise, resistance training, weight training relapse and prevention); 2) explored the views and

perspectives on participating in physical exercise modalities on relapse and prevention; 3) studies could be experimental or quasi-experimental. Online searches of both English and Chinese databases were conducted.

2.3 Data extraction

Data were extracted using a customized Excel spreadsheet. The following data were extracted from the included articles to answer research questions of the current study: year of publication, sampling country, age group of the participants, identity of the participant (i.e., male/female), sample size, physical exercise modalities (frequency, intensity, time and type), types of drug addiction, and measured variables. Two reviewers extracted the data independently from the included studies. A detailed summary of included studies can be found in Appendix 2.

2.4 Quality Assessment

Three critical appraisal checklists developed by the Joanna Briggs Institute (JBI) were used to assess the risk of bias in our included studies, namely the JBI checklist for randomized controlled trials, the JBI checklist for quasi-experimental studies, and the JBI checklist for qualitative research (Institute, 2017a, 2017b, 2017c). The JBI checklist for randomized controlled trials includes 13 questions, the JBI checklist for quasi-experimental studies contains 9 questions, and the JBI checklist for qualitative research includes 10 questions. For each question, the following options were available: 'yes', 'no', 'unclear', and 'not applicable'. The number of 'yes' answers to these questions was counted, with a higher number of 'yes' representing less risk of bias. Studies' quality was characterized as follows: low risk of bias (≥70% of questions answered "yes"), moderate risk of bias (≥50% and < 70% of questions answered "yes"), and high risk of bias (< 50% of questions answered "yes") (Endomba et al., 2022; Goplen et al., 2019). Consequently, for the critical appraisal of quantitative studies, a maximum score of 13 could be obtained for randomized-controlled trials and 9 for quasi-

experimental trials. For the critical appraisal of qualitative studies, a maximum score of 10 could be obtained. For mixed-method studies, a maximum score of 9 could be obtained for the quantitative aspect, and a maximum score of 10 could be obtained for the qualitative aspect. Quality assessment was performed independently by researcher team members (JWP, YTC) and investigators (JLC, LTW, XW) of the project. Disagreements about the quality of the study were resolved after discussion with the members of the scientific committee, and consensus was reached.

2.5 Data Analysis

2.5.1 Objective 1 & 2

To address objectives 1 and 2 of the research report, narrative synthesis was adopted. Specifically, for objective 1, a numerical summary using descriptive statistics was provided to give an overall presentation of the included studies. Population, intervention (informed by Template for intervention description and replication) (TIDieR), comparator, and outcome (PICO) checklists were used as a framework to guide extracting the content of the intervention to address objective 1. To address the priority focus of BDF in the young adult group and female group, a sub-section that focuses on the included studies among young adults group and female group was presented.

To address objective 2, a list of outcomes measured in the included studies was listed.

2.5.2 Objective 3

Based on the list of outcomes identified from objective 2, if the same outcome was measured in at least three included studies, the research team conducted meta-analyses to estimate the overall effect and consistency of the intervention effect across studies. The research team also performed sub-group analyses among young adults and female sub-groups.

Pooled meta-analysis was performed using Comprehensive Meta-Analysis (CMA) V3 software using a random effect model (Biostat, NJ). For controlled trials, data from the exercise intervention and control groups were compared post-intervention in the meta-analysis as mean and standard deviation (SD). For studies with unmatched group data (e.g., crossover trials or pre-post designs), we calculated the difference between baseline and post-test to determine the effects of the intervention. All outcomes were analysed as continuous variables, and pooled statistics were computed using standardised mean differences (SMD) with a 95% confidence interval to allow comparison of data from different scales. The recommended formula (SD = standard error (SE) x √number of participants within a single intervention group) was used to estimate SD when studies reported only SE (Higgins et al., 2022). WebPlotDigitizer, a free web-based software, was used to extract data in graph format (Rohatgi, 2014). When mean and SD were not available (n= 7 studies), we calculated them using the median, range, and sample size suggested by (Hozo et al., 2005). When the data provided was insufficient for the calculation, we contacted the corresponding authors through email (2 responded). Seven studies were excluded from the meta-analysis because the data provided by the authors were insufficient and no response was received after a second contact with the authors. Multiple sensitivity analyses were conducted to identify if any of the findings were affected by the studies not included in the meta-analysis.

To measure statistical heterogeneity, we used the Cochranes Q test and the I^2 test. The Cochranes Q test was used to determine whether observed differences in the results were due to chance, to sampling or methodological variation in the studies. In contrast, the I^2 test quantified the proportion of overall outcomes attributable to variability (Deeks et al., 2019). To determine the degree of heterogeneity, the following values proposed in the Cochrane Handbook of Systematic Reviews were used: I^2=0-40%: heterogeneity might not be significant;

I^2=30-60%: moderate heterogeneity; I^2=50-90%: substantial heterogeneity; I^2=75-100%: considerable heterogeneity (Deeks et al., 2019).

In this report, standardized classifications for the magnitude of effect were used, with less than ≤0.20 representing a small effect, 0.21 to 0.50 representing a medium effect, and ≥0.50 representing a large effect (Cohen, 2013; Takeshima et al., 2014). A *P* value of less than 0.05 was considered statistically significant.

2.5.3 Objective 4

Both original quotations (first-order constructs) and authors' report (second-order constructs) in the result sections of retrieved papers were extracted and exported in full into NVivo 12 (QSR International Pty Ltd.). The analysis went through three major stages. The first stage is an aggregation of qualitative findings into a meta-summary. The second stage adopted the framework method to chart qualitative findings to the quantitative outcome categories identified through objective 2 of the study. The third stage of the analysis integrates interpretively the statement of findings from the meta-summary using meta-synthesis techniques.

3. Results

3.1 Identification of studies

The research retrieved 958 articles, of which 917 were found from academic database and 41 were found by screening the article reference lists. A total of 793 articles were included in the title screening after 165 duplicate articles were removed. Article screening was performed by two independent researchers based on the specified inclusion/exclusion criteria, with a third researcher consulted when consensus on article selection was required. Title and abstract screening filtered out 654 articles. A total of 75 articles met our inclusion criteria, resulting in 58 quantitative, 6 qualitative, and 11 mixed-method studies included in the review. Among all the included studies, 63 articles were in English, and 12 articles were in Chinese. All qualitative studies and mixed-method studies were published in English only. A flow diagram of study selection as adapted from Preferred Reporting Items for Systematic Reviews and Meta-analyses (Liberati et al., 2009) is shown in Figure 1.

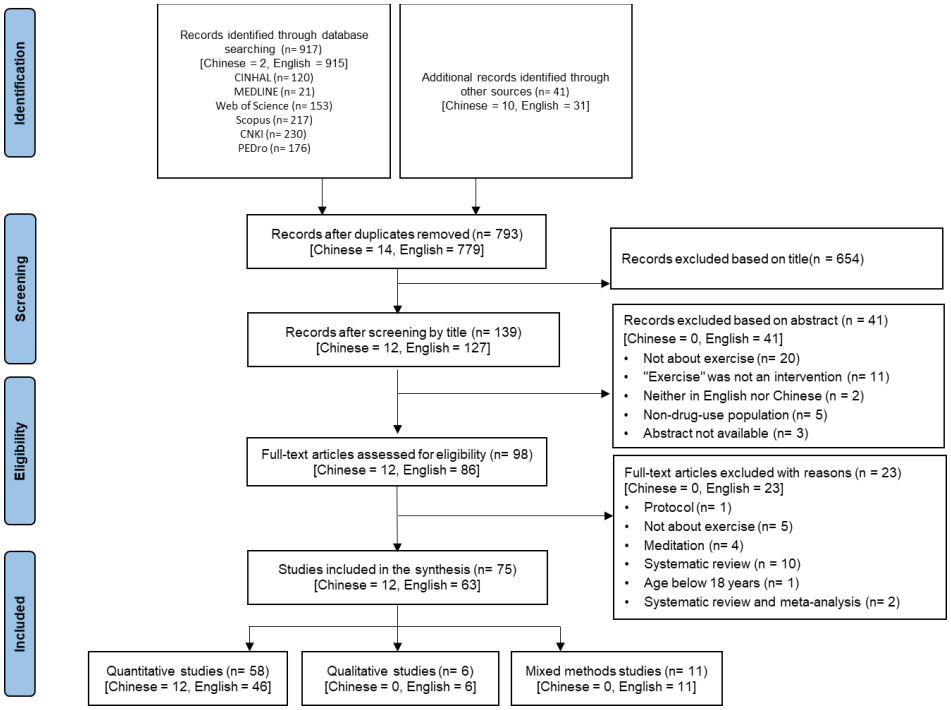


Figure 1 PRISMA Flow Chart

3.2 Studies' Characteristics

Table 1 shows the characteristics of the 75 included studies. These studies were published between 1992 and 2022. Of the fifty-eight quantitative studies, forty-two were randomized-controlled trials, and sixteen were non-randomized-controlled trials. The six qualitative studies used different methodological orientations and methods, including one study using grounded theory, one study using ethnography, observation and field notes, a biographical case study using in-depth and semi-structured interviews with a longitudinal approach, and three descriptive qualitative studies which used individual/focus group interviews, and semi-structured evaluation interviews. The eleven mixed-methods studies used randomized controlled trials, nonrandomized controlled trials, randomized trials, pilot studies, and before-and-after studies to collect quantitative data. In contrast, semi-structured, structured, and in-depth interviews, questionnaires, spontaneous feedback or open-ended questions, observation, self-report and the sophist group technique and a thematic analysis approach were used to collect qualitative data.

The majority of studies were conducted in China and the United States, followed by Norway, Nepal, the United Kingdom, Greece, Ireland, Georgia, India, Iran, Sweden, Switzerland, Spain, and Denmark. A total of 5079 individuals with drug dependence from the 75 studies were analysed. Of these drug-dependent subjects, sixty-four (85.3%) studies recruited drug addicts without specific characteristics, three studies (4.0%) recruited drug addicts who are offenders or prisoners, two studies (2.7%) recruited drug addicts with comorbid mental disorders, two studies (2.7%) recruited drug addicts who are veterans, and two studies (2.7%) recruited drug addicts with HIV infection. The remaining two studies (2.6%) recruited drug addicts requiring behavioural management (1.3%) and drug addicts with posttraumatic stress disorder (1.3%).

Of the sixty-five studies for which recruitment strategy information was available, nearly two-thirds (63.1%) were from inpatient facilities, approximately one-third (30.8%) were from outpatient facilities, and the remainder (6.2%) were from both inpatient and outpatient facilities. The majority of study participants voluntarily participated in the study; a small proportion were coerced into participation or referred to the study by members of the addiction programme, general practitioners, or drug workers.

Among the included studies which provided information on the gender of the participants, 1573 (46.83%) participants were men, 1368 (40.73%) participants were women, and 1 (0.03%) participant was a transgender person. The remaining 417 (12.41%) subjects in these seventy-five studies did not specify the gender of the study participants in the exercise intervention group. The mean sample size of the intervention group was 44.79, ranging from 2 to 318 participants. The mean age of the intervention group was 34.6 years.

Table 1. Major characteristics of included studies

Study Characteristics	Number of Articles	Studies' Code
Country		
China	30 (40.0%)	[5, 7, 10, 11, 14, 15, 18, 28, 29, 32, 37, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 63, 79, 80]
United States	23 (30.7%)	[2, 3, 4, 6, 8, 12, 19, 21, 23, 30, 33, 34, 35, 36, 38, 39, 42, 64, 65, 66, 67, 74, 76]
Norway	5 (6.7%)	[16, 24, 60, 62, 72]
Nepal	3 (4.0%)	[9, 13, 25]
United Kingdom	3 (4.0%)	[69, 73, 77]
Greece	2 (2.7%)	[20, 78]
Ireland	2 (2.7%)	[68, 71]
Iran	1 (1.3%)	[61]

Georgia	1 (1.3%)	[40]
India	1 (1.3%)	[22]
Sweden	1 (1.3%)	[41]
Switzerland	1 (1.3%)	[1]
Spain	1 (1.3%)	[70]
Denmark	1 (1.3%)	[75]
Language		
English	63 (84.0%)	[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 28, 29, 30, 32, 33, 34, 35, 36, 38, 39, 40, 41, 42, 49, 51, 52, 53, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80]
Chinese	12 (16.0%)	[37, 44, 45, 46, 47, 48, 50, 54, 55, 56, 57, 58]
Research Type		
Quantitative	58 (77.3%)	[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 24, 25, 28, 29, 30, 32, 33, 34, 35, 36, 37, 38, 39, 41, 42, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 67, 79, 80]
Qualitative	6 (8.0%)	[68, 69, 71, 76, 77, 78]
Mixed method	11 (14.7%)	[22, 23, 40, 64, 65, 66, 70, 72, 73, 74, 75]
Drug-dependent population with specific characteristics/conditions		
Drug addict without specific characteristics/conditions	64 (85.3%)	[1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 22, 23, 24,

		25, 28, 29, 30, 32, 33, 34, 35, 36, 37, 38, 39, 41, 42, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 61, 62, 63, 64, 69, 70, 71, 72, 73, 75, 76, 78, 79, 80]
Offenders/ prisoners	3 (4.0%)	[68, 74, 77]
Comorbid mental disorder	2 (2.7%)	[16, 60]
Veterans	2 (2.7%)	[65, 66]
HIV	2 (2.7%)	[3, 4]
Individuals require behavioral management	1 (1.3%)	[40]
PTSD (veteran and civilian)	1 (1.3%)	[67]
Gender of participants		
Studies that include both gender	33 (44.0%)	[1, 2, 3, 5, 6, 8, 12, 16, 19, 21, 24, 33, 34, 35, 36, 38, 39, 41, 42, 52, 53, 55, 56, 58, 62, 64, 65, 66, 70, 71, 72, 73, 75]
Male only	22 (29.3%)	[4, 7, 9, 10, 13, 14, 20, 22, 25, 28, 32, 49, 59, 60, 61, 63, 68, 69, 77, 78, 79, 80]
Female only	20 (26.7%)	[11, 15, 18, 23, 29, 30, 37, 40, 44, 45, 46, 47, 48, 50, 51, 54, 57, 67, 74, 76]
Treatment setting		
Inpatient setting	41	[4, 7, 9, 10, 11, 12, 13, 14, 15, 16, 19, 20, 21, 22, 24, 25, 28, 29, 34, 37, 38, 42, 44, 45, 46, 48, 50, 51, 54, 55, 56, 58, 59, 60, 62, 63, 66, 72, 74, 78, 80]
Outpatient setting	20	[1, 2, 3, 8, 30, 33, 35, 36, 39, 40, 61, 65, 67,

		68, 69, 71, 73, 75, 77, 79]
Both	4	[23, 41, 64, 76]
Nonspecific/Did not mention	10	[5, 6, 18, 32, 47, 49, 52, 53, 57, 70]
Treatment option		
Compulsory	18	[7, 14, 28, 29, 37, 45, 46, 47, 50, 51, 54, 55, 56, 57, 58, 59, 63, 80]
Voluntary	36	[1, 2, 3, 4, 8, 9, 10, 11, 15, 16, 19, 20, 22, 23, 25, 30, 33, 34, 35, 36, 40, 41, 42, 44, 60, 64, 65, 66, 67, 68, 69, 71, 72, 74, 77, 79]
Other	3	[73, 75, 76]
Nonspecific	18	[5, 6, 12, 13, 18, 21, 24, 32, 38, 39, 48, 49, 52, 53, 61, 62, 70, 78]

3.3 Methodological Quality of the Included Studies

Tables 2, 3, 4, and 5 show the quality appraisals of the included studies using the JBI critical appraisal tools.

Forty-two RCTs were assessed for study quality using the JBI checklist for randomized controlled trials and sixteen non-RCTs were assessed using the JBI checklist for quasi-experimental studies. The average score of the studies was 7.98 (±1.52) out of 13 for RCTs and 6.75 (±1.24) out of 9 for non-RCTs respectively. Overall, of the 58 quantitative studies, 18 were rated as low risk (≥ 70%), 32 as moderate risk (≥50% and <70%), and 8 as high risk (<50%) for bias. The major weakness of these studies was the lack of strategies to control concealed allocation and blinding of assessment. This resulted in four (codes 19, 28, 29 and 46) of the eight studies with high risk of bias being excluded from the meta-analysis despite sufficient data.

Of the six qualitative studies assessed for study quality using the JBI checklist for qualitative studies, four were rated as low risk (≥ 70%), and two were rated as high risk (<50%) for bias. The average score of the studies was 7.33 (±1.63) out of 10. The major weakness of these studies was the lack of statements about the researcher's cultural or theoretical orientation and the researcher's influence on the research, with only one of the six studies achieving these criteria.

Eleven mixed-method studies were assessed for study quality using the JBI checklist for quasi-experimental studies for the quantitative aspect and the JBI checklist for qualitative studies for the qualitative aspect. The average score of the studies was 6.18 (±1.33) out of 9 for the quantitative domain and 5.73 (±2.94) out of 10 for the qualitative domain. Three of the eleven studies were rated as low risk (≥ 70%) of bias, seven were rated as moderate risk (≥50% and <70%), and one was rated as high risk (<50%) of bias in the quantitative domain.

The major weakness of these studies was the lack of an independent control group to examine the validity of the causal plausibility. Six of the eleven studies were rated as low risk (≥ 70%) of bias, three as moderate risk (≥50% and <70%), and two as high risk (<50%) of bias in the qualitative domain. Similar to the pure quantitative and qualitative studies as mentioned above, mixed-method studies lack an independent control group to examine the validity of the causal plausibility and lack statements about the researcher's cultural or theoretical orientation and the researcher's influence on the research. Despite two studies (code 22, 66) being rated as having a high risk of bias, the quality of the qualitative and mixed-methods studies did not influence the aggregation.

Table 2 Quality of included quantitative studies using the Joanna Briggs Institute appraisal tool

			Items on Joanna Briggs Institute[a]														
Code	Study reference	Study type	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Raw score and %	Risk
1	Colledge et al. (2017)	RCT	Y	Y	Y	N	N	N	N	Y	N	Y	Y	Y	Y	8/13 = 61.5%	Moderate
2	Cutter et al. (2014)	RCT	N	N	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	8/13 = 61.5%	Moderate
3	Wimberly et al. (2018)	RCT	Y	Y	Y	Y	UC	N	Y	Y	Y	Y	Y	Y	Y	11/13 = 84.6%	Low
4	Vingren et al. (2018)	RCT	Y	N	Y	N	N	N	N	Y	Y	UC	Y	Y	Y	7/13 = 53.8%	Moderate
8	Shaffer et al. (1997)	RCT	Y	Y	Y	N	N	N	N	N	N	Y	UC	UC	Y	5/13 = 38.5%	High
9	Gaihre & Rajesh (2018a)	RCT	Y	N	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	9/13 = 69.2%	Moderate
11	Ding et al. (2021)	RCT	Y	N	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	9/13 = 69.2%	Moderate
12	Robertson et al. (2016)	RCT	UC	Y	Y	N	N	N	Y	NA	Y	Y	Y	Y	Y	8/13 = 61.5%	Moderate
13	Gaihre & Rajesh (2018b)	RCT	Y	N	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	8/13 = 61.5%	Moderate
14	Zhu et al. (2021)	RCT	Y	UC	Y	N	N	UC	Y	NA	Y	Y	UC	Y	Y	7/13 = 53.8%	Moderate
16	Ellingsen et al. (2021)	RCT	Y	N	Y	N	N	N	Y	N	Y	Y	Y	Y	Y	8/13 = 61.5%	Moderate
18	Li et al. (2013)	RCT	Y	N	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y	9/13 = 69.2%	Moderate
21	Dolezal et al. (2013)	RCT	Y	Y	Y	N	N	N	N	N	Y	UC	Y	Y	Y	7/13 = 53.8%	Moderate
25	Gaihre et al. (2021)	RCT	Y	N	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	8/13 = 61.5%	Moderate
28	Zhu et al. (2020)	RCT	UC	UC	Y	N	N	UC	Y	Y	UC	Y	UC	Y	Y	6/13 = 46.2%	High
29	Zhu et al. (2018a)	RCT	Y	UC	N	N	N	UC	Y	Y	UC	Y	UC	Y	Y	6/13 = 46.2%	High
30	Price et al. (2012)	RCT	Y	N	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	8/13 = 61.5%	Moderate
32	Wang et al. (2019)	RCT	N	N	Y	UC	UC	Y	Y	NA	Y	Y	UC	Y	UC	6/13 = 46.2%	High
33	Brellenthin et al. (2021)	RCT	Y	N	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	9/13 = 69.2%	Moderate

34	Trivedi et al. (2017)	RCT	Y	N	Y	N	N	N	Y	N	Y	Y	Y	Y	Y	8/13 = 61.5%	Moderate
35	Alessi et al. (2020)	RCT	Y	Y	Y	N	N	Y	Y	N	Y	Y	Y	Y	Y	10/13 = 77%	Low
36	De La Garza 2nd et al. (2016)	RCT	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	10/13 = 77%	Low
37	Zhang et al. (2020)	RCT	Y	UC	Y	N	N	UC	Y	NA	Y	Y	UC	Y	Y	7/13 = 53.8%	Moderate
38	Carmody et al. (2018)	RCT	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	Y	Y	10/13 = 77%	Low
39	Uebelacker et al. (2019)	RCT	Y	N	Y	N	N	N	Y	Y	Y	Y	Y	UC	Y	8/13 = 61.5%	Moderate
41	Hovhannisyan et al. (2020)	RCT	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	11/13 = 84.6%	Low
42	Rawson et al. (2015)	RCT	Y	N	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	8/13 = 61.5%	Moderate
44	Zhu et al. (2018b)	RCT	N	N	Y	N	Y	N	Y	Y	UC	Y	UC	Y	N	6/13 = 46.2%	High
46	Zhu et al. (2022)	RCT	N	NA	N	NA	UC	UC	Y	UC	Y	Y	Y	Y	N	5/13 = 38.5%	High
49	Lu et al. (2021)	RCT	Y	UC	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	10/13 = 77%	Low
50	Yao & Chen (2020)	RCT	Y	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	UC	9/13 = 69.2%	Moderate
51	Zhuang et al. (2013)	RCT	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	11/13 = 84.6%	Low
53	Wang et al. (2016)	RCT	Y	N	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	9/13 = 69.2%	Moderate
54	Fu et al. (2016)	RCT	Y	N	Y	N	UC	UC	Y	Y	Y	Y	Y	Y	Y	9/13 = 69.2%	Moderate
55	Huang et al. (2015)	RCT	Y	UC	Y	UC	N	N	Y	Y	Y	Y	UC	Y	Y	8/13 = 61.5%	Moderate
56	Li et al. (2018)	RCT	Y	UC	Y	UC	UC	UC	Y	Y	Y	Y	Y	Y	N	8/13 = 61.5%	Moderate
57	Zhu et al. (2016)	RCT	UC	N	Y	N	N	UC	Y	Y	Y	Y	UC	Y	Y	7/13 = 53.8%	Moderate
58	Huang et al. (2017)	RCT	Y	UC	Y	N	N	N	N	Y	Y	Y	UC	Y	UC	6/13 = 46.2%	High
59	Li et al. (2022)	RCT	N	N	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	7/13 = 53.8%	Moderate
61	Marefat et al. (2011)	RCT	N	N	Y	UC	UC	UC	N	Y	Y	Y	Y	Y	Y	7/13 = 53.8%	Moderate
67	Reddy et al. (2014)	RCT	Y	N	Y	N	N	N	Y	Y	Y	N	Y	Y	Y	8/13 = 61.5%	Moderate

79	Zhao et al., (2020)	RCT	Y	N	Y	N	N	N	N	UC	Y	Y	Y	Y	Y	7/13 = 53.8%	Moderate

Note.

[a] (Q1) Was true randomization used for the assignment of participants to treatment groups?; (Q2) Was allocation to treatment groups concealed?; (Q3) Were treatment groups similar at the baseline?; (Q4) Were participants blind to treatment assignment?; (Q5) Were those delivering treatment blind to treatment assignment?; (Q6) Were outcomes assessors blind to treatment assignment?; (Q7) Were treatment groups treated identically other than the intervention of interest?; (Q8) Was follow-up complete, and if not, were differences between groups in terms of their follow-up adequately described and analyzed?; (Q9) Were participants analyzed in the groups to which they were randomized?; (Q10) Were outcomes measured in the same way for treatment groups?; (Q11) Were outcomes measured in a reliable way?; (Q12) Was appropriate statistical analysis used?; (Q13) Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?

Abbreviations: RCT = randomized controlled trial; Y (Yes) = 1, N (No) or Unclear (UC) or Not Applicable (NA) = 0

Criteria used to rank the risk of bias:

i) ≥ 70% = low risk of bias

ii) ≥50% and <70% = moderate risk of bias

iii) <50% = high risk of bias

			Items on Joanna Briggs Institute[a]														
Code	Study reference	Study type	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Raw score and %	Risk
5	Wang et al. (2017)	Pre-post	Y	Y	UC	Y	Y	Y	Y	Y	Y					8/9 = 88.9%	Low
6	Buchowski et al. (2011)	Pre-post	Y	NA	NA	N	Y	Y	Y	Y	Y					6/9 = 66.67%	Moderate
7	Zhu et al. (2016a)	Quasi-experimental trial	Y	Y	N	Y	Y	Y	Y	Y	Y					8/9 = 88.9%	Low
10	Liu & Wang (2021)	Pre-post	Y	Y	UC	Y	Y	NA	Y	Y	Y					7/9 = 77.78%	Low
15	Zhou et al. (2021)	Quasi-experimental study	Y	Y	Y	Y	N	NA	Y	UC	Y					6/9 = 66.67%	Moderate
19	Palmer et al. (1995)	Pre-post	Y	UC	NA	N	Y	NA	Y	UC	UC					3/9 = 33.3%	High

20	Vlachopoulou et al. (2005)	Pre-post	Y	UC	N	Y	Y	Y	Y	Y	Y					7/9 = 77.78%	Low
24	Flemmen et al. (2014)	Pre-post	Y	Y	N	Y	Y	NA	Y	Y	Y					7/9 = 77.78%	Low
45	Zhao et al. (2022)	Pre-post	Y	Y	UC	Y	Y	NA	Y	Y	Y					7/9 = 77.78%	Low
47	Liang et al. (2019)	Pre-post	Y	Y	Y	Y	Y	NA	Y	Y	Y					8/9 = 88.9%	Low
48	Chen et al. (2019)	Pre-post	Y	Y	N	Y	N	NA	Y	Y	Y					6/9 = 66.67%	Moderate
52	Wang et al. (2015)	Pre-post	Y	Y	N	N	Y	Y	Y	Y	Y					7/9 = 77.78%	Low
60	Ellingsen et al. (2018)	Pre-post	Y	Y	Y	N	Y	NA	Y	UC	Y					6/9 = 66.67%	Moderate
62	Unhjem et al. (2016)	Pre-post	Y	Y	Y	Y	Y	Y	Y	UC	Y					8/9 = 88.9%	Low
63	He et al. (2021a)	Pre-post	Y	Y	Y	Y	Y	NA	Y	UC	Y					7/9 = 77.78%	Low
80	He et al. (2021b)	Pre-post	Y	Y	Y	Y	N	NA	Y	Y	Y					7/9 = 77.78%	Low

Note.

[a] (Q1) Is it clear in the study what the 'cause' and 'effect' are (i.e. there is no confusion about which variable comes first)?; (Q2) Were the participants included in any comparisons similar?; (Q3) Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?; (Q4) Was there a control group?; (Q5) Were there multiple measurements of the outcome both pre and post intervention/exposure?; (Q6) Was follow-up complete, and if not, were differences between groups in terms of their follow-up adequately described and analyzed?; (Q7) Were the outcomes of participants included in any comparisons measured in the same way?; (Q8) Were outcomes measured in a reliable way?; (Q9) Was appropriate statistical analysis used?

Abbreviations: Y (Yes) = 1, N (No) or Unclear (UC) or Not Applicable (NA) = 0

Criteria used to rank the risk of bias:

i) ≥ 70% = low risk of bias

ii) ≥50% and <70% = moderate risk of bias

iii) <50% = high risk of bias

Table 3 Quality of included qualitative studies using the Joanna Briggs Institute appraisal tool

			Items on Joanna Briggs Institute[a]														
Code	Study reference	Study type	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Raw score and %	Risk
68	Van Hout & Phelan (2014)	Case study/grounded theory (in-depth interviews)	Y	Y	Y	Y	Y	N	N	Y	Y	Y				8/10 = 80%	Low
69	Curran et al. (2016)	Ethnography	Y	Y	Y	Y	Y	Y	UC	Y	Y	Y				9/10 = 90%	Low
71	Morton et al. (2016)	Focus group/thematic analysis	U C	N	Y	N	Y	N	N	Y	Y	Y				5/10 = 50%	Moderate
76	Smoyer (2016)	Survey and semi-structured interviews	U C	N	Y	Y	Y	N	Y	Y	UC	Y				6/10 = 60%	Moderate
77	Landale & Roderick (2014)	Biological case studies, and prospective study: in-depth and semi-structured interviews	Y	Y	Y	Y	Y	N	N	Y	N	Y				7/10 = 70%	Low
78	Diamantis (2017)	In-depth individual interviews, focus group interviews, and observations	Y	Y	Y	Y	Y	Y	Y	Y	N	Y				9/10 = 90%	Low

Note.

[a] (Q1) Is there congruity between the stated philosophical perspective and the research methodology?; (Q2) Is there congruity between the research methodology and the research question or objectives?; (Q3) Is there congruity between the research methodology and the methods used to collect data?; (Q4) Is there congruity between the research methodology and the representation and analysis of data?; (Q5) Is there congruity between the research methodology and the interpretation of results?; (Q6) Is there a statement locating the researcher culturally or theoretically?; (Q7) Is the researcher's influence on the research, and vice-versa, addressed?; (Q8) Are participants and their voices adequately represented?; (Q9) . Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?; (Q10) Do the conclusions drawn in the research report flow from the analysis or interpretation of the data?

Abbreviations: Y (Yes) = 1, N (No) or Unclear (UC) = 0

Criteria used to rank the risk of bias:

i) ≥ 70% = low risk of bias

ii) ≥50% and <70% = moderate risk of bias

iii) <50% = high risk of bias

Table 4 Quality of included mixed-method studies using the Joanna Briggs Institute appraisal tool (Quantitative aspect)

			Items on Joanna Briggs Institute[a]														
Code	Study reference	Study type	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Raw score and %	Risk
22	Khalsa (2008)	Pre-post	Y	UC	Y	N	NA	Y	Y	Y	Y					6/9 = 66.67%	Moderate
23	Amaro (2014)	Pre-post	Y	Y	Y	N	Y	Y	Y	Y	Y					8/9 = 88.89%	Low
40	Cevasco et al. (2005)	Pre-post	Y	Y	NA	N	Y	NA	Y	UC	Y					5/9 = 55.56%	Moderate
64	Brown et al. (2010)	Pre-post	Y	Y	NA	N	Y	Y	Y	UC	Y					6/9 = 66.67%	Moderate
65	Linke et al. (2019)	Pre-post	Y	NA	NA	N	Y	Y	Y	Y	Y					6/9 = 66.67%	Moderate
66	Burling et al. (1992)	Quasi-experimental trial (3 arm)	N	Y	NA	N	NA	Y	Y	NA	Y					4/9 = 44.44%	High
70	Giménez-Meseguer et al. (2015)	Pre-post	Y	Y	Y	Y	Y	NA	Y	Y	Y					8/9 = 88.89%	Low
72	Muller & Clausen (2015)	Pre-post	Y	Y	NA	N	N	NA	Y	Y	Y					5/9 = 55.56%	Moderate
73	Beynon et al. (2013)	Pre-post	Y	Y	Y	N	Y	Y	Y	Y	Y					8/9 = 88.89%	Low
74	Peterson & Johnstone (1995)	Pre-post	Y	Y	Y	N	Y	NA	Y	UC	Y					6/9 = 66.67%	Moderate

75	Roessler (2010)	Pre-post	Y	Y	Y	N	Y	NA	Y	UC	Y					6/9 = 66.67%	Moderate

Note.

[a] (Q1) Is it clear in the study what the 'cause' and 'effect' are (i.e. there is no confusion about which variable comes first)?; (Q2) Were the participants included in any comparisons similar?; (Q3) Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?; (Q4) Was there a control group?; (Q5) Were there multiple measurements of the outcome, both pre and post intervention/exposure?; (Q6) Was follow-up complete, and if not, were differences between groups in terms of their follow-up adequately described and analyzed?; (Q7) Were the outcomes of participants included in any comparisons measured in the same way?; (Q8) Were outcomes measured in a reliable way?; (Q9) Was appropriate statistical analysis used?

Abbreviations: Y (Yes) = 1, N (No) or Unclear (UC) or Not Applicable (NA) = 0

Criteria used to rank the risk of bias:

i) ≥ 70% = low risk of bias

ii) ≥50% and <70% = moderate risk of bias

iii) <50% = high risk of bias

Table 5 Quality of included mixed-method studies using the Joanna Briggs Institute appraisal tool (Qualitative aspect)

			Items on Joanna Briggs Institute[a]														
Code	Study reference	Study type (Qualitative aspect)	Q 1	Q 2	Q 3	Q 4	Q5	Q 6	Q 7	Q 8	Q9	Q1 0	Q1 1	Q1 2	Q13	Raw score and %	Risk
22	Khalsa (2008)	Pre-post (open-ended questions from questionnaire)	N	N	N	N	N	N	N	N	N	N A				0/10 = 0%	High
23	Amaro (2014)	Pre-post (open-ended questions from questionnaire)	Y	Y	Y	Y	Y	N A	Y	Y	Y	N				8/10 = 80%	Low
40	Cevasco et al. (2005)	Pre-post (written comments of the intervention)	Y	Y	Y	Y	Y	N	N	N	N	Y				6/10 = 60%	Moderate
64	Brown et al. (2010)	Pre-post (open-ended questions from questionnaire)	Y	Y	Y	Y	Y	N	N	N	N	Y				6/10 = 60%	Moderate
65	Linke et al. (2019)	Pre-post (interview)	Y	Y	Y	Y	Y	N	N	N	Y	Y				7/10 = 70%	Low
66	Burling et al. (1992)	Quasi-experimental trial (3 arm) (informal interview)	N A	N A	N A	N A	N A	N	N	N	N	N A				0/10 = 0%	High
70	Giménez-Meseguer et al. (2015)	Pre-post (interview)	Y	Y	Y	Y	Y	N	N	Y	Y	Y				8/10 = 80%	Low
72	Muller & Clausen (2015)	Pre-post (open-ended questions from questionnaire)	Y	Y	Y	Y	Y	N	N	N	Y	Y				7/10 = 70%	Low
73	Beynon et al. (2013)	Pre-post (semi-structured topic-guided telephone interviews)	Y	Y	Y	Y	Y	N	N	N	Y	Y				7/10 = 70%	Low
74	Peterson & Johnstone (1995)	Pre-post (focus group interview)	Y	Y	Y	Y	Y	N	N	Y	Y	Y				8/10 = 80%	Low
75	Roessler (2010)	Pre-post (focus group interview)	Y	Y	Y	Y	Y	N	N	N	N	Y				6/10 = 60%	Moderate

Note.

[a] (Q1) Is there congruity between the stated philosophical perspective and the research methodology?; (Q2) Is there congruity between the research methodology and the research question or objectives?; (Q3) Is there congruity between the research methodology and the methods used to collect data?; (Q4) Is there congruity between the research methodology and the representation and analysis of data?; (Q5) Is there congruity between the research methodology and the interpretation of results?; (Q6) Is there a statement locating the researcher culturally or theoretically?;

(Q7) Is the researcher's influence on the research, and vice-versa, addressed?; (Q8) Are participants and their voices adequately represented?; (Q9) . Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?; (Q10) Do the conclusions drawn in the research report flow from the analysis or interpretation of the data?

Abbreviations: RCT = randomized controlled trial; Y (Yes) = 1, N (No) or Not Applicable (NA) = 0

Criteria used to rank the risk of bias:

i) ≥ 70% = low risk of bias

ii) ≥50% and <70% = moderate risk of bias

iii) <50% = high risk of bias

3.4 Objective 1: To identify physical exercise interventions for the drug-dependent group from the literature

This section presented an overview of all the different types of physical exercise interventions for the drug-dependent population and physical exercise experienced by the drug-dependent population identified in the included studies. Details of the intervention content of the included studies are presented in Table 6 using the TIDieR checklist (Hoffmann et al., 2014).

Exercise type

Among the included studies that provided information on the type of exercise intervention, the three major types of physical exercise being investigated were mind-body exercise[i], aerobic exercise[ii], and structured fitness training programme[iii]. Mind-body exercise[i] was the most commonly investigated type of exercise (n= 26, 28.0%). Aerobic exercise[ii] was the second most commonly examined type of exercise (n= 25, 26.9%). The third most commonly investigated exercise type was structured fitness training programme[iii] (n= 20, 21.5%). The remaining studies examined the effects of a mixture of leisure activities and exercise[iv] (n= 5, 5.4%), sports[v] (n= 4, 4.3%), a mixture of sport and exercise[vi] (n= 4, 4.3%), movement therapy in combination with another modality[vii] (n= 4, 4.3%), individualized PA tailored by an interventionist[viii] (n= 3, 3.2%), videogame-based exercise[ix] (n= 1, 1.1%), and nonspecific physical fitness training (n= 1, 1.1%).

Intervention duration

The intervention duration of all exercise interventions ranged from one session to one year. Most of the included studies had an intervention duration of 9-12 weeks (n= 31, 34.4%), followed by less than 4 weeks (n= 21, 23.3%) and 5-8 weeks (n= 19, 21.1%).

Duration per session

In the majority of studies (n= 42, 44.7%), the duration per session lasted less than 60 minutes, followed by 60 minutes (n= 18, 19.1%), 61-90 minutes (n= 16, 17.0%), and more than 90 minutes (n= 8, 8.5%). Ten studies (10.6%) did not report the duration of the intervention per session.

Exercise dosage (F.I.T.T)

Regarding the dosage of the physical exercise intervention, thirty-four studies (36.2%) provided information on the exercise intervention's frequency, type, and time prescribed to study participants. Twenty-two studies (23.4%) provided information on the exercise intervention's frequency, intensity, type, and time. Twenty studies (21.3%) provided information on the exercise intervention's frequency and time. Eight studies (8.5%) provided information on the exercise intervention's frequency, intensity, and time. Three studies (3.2%) provided information on frequency only. Three studies (3.2%) did not provide any information on the exercise intervention's frequency, intensity, type, and time. Two studies (2.1%) provided information on frequency and type only. One study (1.1%) provided information on frequency and intensity, and one study (1.1%) provided information on the exercise intervention's time only.

Intervention supervision

Of the eighty-six studies providing information on intervention supervision mode, almost all exercise interventions (n= 76, 80.4%) were supervised. Five studies (5.8%) were self-administered, and five (5.8%) used a combination of supervised and unsupervised self-selected physical activity.

Intervention component

The majority of studies (n= 77, 81.9%) adopted exercise as the primary intervention. Fourteen studies (15.0%) were multi-component interventions, exercise interventions in fifteen studies (16.0%) were conducted along with health education or psychotherapy components, and two studies (2.1%) conducted exercise interventions along with the pharmacological therapy components.

Intervention provider

A wide range of personnel was involved in providing and directing exercise interventions. Among all the supervised exercise interventions, sport instructors were involved in nearly half of the studies (n= 32, 34.0%), a multidisciplinary team was involved in eleven studies (11.7%), nonspecific staff or professionals were involved in six studies (6.4%), trained yoga instructors were involved in five studies (5.3%), and it was the same case for unsupervised intervention (n=5, 5.3%), therapists were involved in three studies (3.2%), study personnel with a physical education background were involved in three studies (3.2%), licensed massage therapists were involved in two studies (2.1%), trained facilitators were involved in one study (1.1%), consultants were involved in one study (1.1%), and nurses were involved in one study (1.1%). In the remaining twenty-four studies (25.5%), no information was provided on the personnel who delivered the exercise intervention.

Table 6 The current scope of evidence

PICo/TIDieR item	**PICO, adapted TIDieR**	**Number of articles**	**Studies' code**
Intervention			
	Major Exercise type		
	Mind-body exercise	26 (28.0%)	[3, 7, 8, 9, 13, 18, 22, 23, 25, 28, 29, 39, 44, 47, 50, 51, 54, 55, 57, 58#, 59, 61, 67, 76, 80]

Aerobic exercises	25 (26.9%)	[5, 6, 10, 11, 14, 15#, 19, 32#, 33, 36#, 37, 45#, 49, 52, 53#, 60, 64, 74, 79]
Structure fitness training	20 (21.5%)	[4, 9, 13, 19#, 20, 21, 25, 42, 46#, 49, 56, 60, 63#, 65, 71, 73, 75]
Mixture of leisure activities and exercise	5 (5.4%)	[24, 35, 62, 68, 70]
Mixture of sport and exercise	4 (4.3%)	[1, 16, 72, 78]
Sports	4 (4.3%)	[60, 66, 69, 77]
Movements therapy in combination with another modality	4 (4.3%)	[30, 40, 48, 56]
Individualized PA tailored by interventionist	3 (3.2%)	[12, 34, 38]
Videogame-based exercise	1 (1.1%)	[2]
Nonspecific physical fitness training	1 (1.1%)	[50]
Intervention duration		
≤ 4 weeks	21 (23.3%)	[6, 15#, 16, 19#, 32, 36#, 53#, 59, 60#, 63#, 80]
5-8 weeks	19 (21.1%)	[2, 4, 10, 11, 12, 20, 21, 24, 30, 33, 37, 40, 41, 42, 48, 61, 62, 68, 73]
9-12 weeks	31 (34.4%)	[1, 3, 5, 7, 9#, 13#, 14, 23, 25#, 28, 34, 38, 39, 46#, 47, 49#, 50#, 56#, 64, 65, 69, 70, 72, 79]
13-24 weeks	17 (18.9%)	[8, 18, 22, 29, 35, 44, 51, 54, 55, 57, 58#, 66, 71, 75, 76, 78]

	25-36 weeks	0 (0%)	
	≥36 weeks	2 (2.2%)	[74, 77]
	Duration per session		
	< 60 minutes	42 (44.7%)	[2, 5, 6, 14, 15#, 16, 19#, 20, 21, 24, 29, 32#, 33, 35, 36#, 37, 42, 44, 45#, 47, 48, 49, 51, 52, 53#, 54, 55, 58#, 64, 72, 76, 79, 80]
	60 minutes	18 (19.1%)	[7, 10, 12, 18, 28, 39, 40, 50#, 56, 57, 60#, 61, 63#, 78]
	61-90 minutes	16 (17.0%)	[3, 8, 9#, 11, 13#, 25#, 30, 41, 46#, 65, 67, 70]
	> 90 minutes	8 (8.5%)	[1, 23, 38, 59, 69, 71, 74, 75]
	Not mentioned	10 (10.6%)	[4, 22, 34, 49, 56, 62, 66, 68, 73, 77]
	Exercise dosage		
	Exercise intervention which provides details in frequency, type, and time only	34 (36.2%)	[3, 7, 8, 9#, 13#, 18, 23, 25#, 29, 39, 42, 44, 45#, 47, 48, 51, 54, 55, 57, 58#, 59, 60#, 61, 67, 69, 74, 76, 80]
	Exercise intervention which provides details in frequency, intensity, type, and time	22 (23.4%)	[6, 10, 11, 15#, 21, 32#, 33, 34, 36#, 37, 49#, 50, 52, 53#, 64, 79]
	Exercise intervention which provides details in frequency and time only	20 (21.3%)	[2, 16, 19#, 20, 28, 30, 35, 40, 56#, 63#, 65, 70, 71, 72, 75, 78]

Exercise intervention which provides details in frequency, intensity, and time only	8 (8.5%)	[5, 12, 14, 24, 38, 46#, 60]
Exercise intervention which provides details in frequency only	3 (3.2%)	[1, 4, 73]
Exercise intervention which did not provide details in frequency, intensity, type, and time	3 (3.2%)	[50, 68, 77]
Exercise intervention which provides details in frequency and type only	2 (2.1%)	[22, 66]
Exercise intervention which provides details in time only	1 (1.1%)	[41]
Exercise intervention which provides details in frequency and intensity only	1 (1.1%)	[62]
Intervention supervision		
Supervised exercise only	76 (80.4%)	[1, 2, 4, 5, 6, 7, 8, 9#, 10, 11, 12, 13#, 14, 15, 16, 18, 19#, 21, 22, 23, 24, 25#, 28, 29, 30, 33, 34, 35, 37, 38, 39, 40, 42, 44, 45#, 46#, 47, 48, 49#, 50#, 51, 52, 53#, 54, 55, 56#, 57, 58#, 60#, 61, 62, 63#, 64, 66, 69, 70, 72, 73, 75, 76, 79]
Supervised and unsupervised self-selected physical activity	5 (5.8%)	[3, 41, 65, 74, 78]
Self-practice	5 (5.8%)	[15, 19, 59, 68, 77]
Intervention component		
Exercise only	77 (81.9%)	[1, 3, 4, 5, 6, 7, 8, 9#, 10, 11, 12, 13#, 14, 15#, 18, 19#, 20, 21, 22, 24, 25#, 28,

			29, 30, 32#, 33, 34, 37, 38, 39, 40, 42, 44, 45#, 46#, 47, 48, 49#, 50#, 51, 52, 53#, 56#, 57, 58, 59, 60#, 61, 62, 63#, 68, 70, 72, 73, 75, 76, 77, 78, 79, 80]
	Exercise sessions in combination with health education or psychotherapy	15 (16.0%)	[16, 23, 35, 36#, 41, 54, 55, 64, 65, 66, 67, 69, 71, 74]
	Exercise sessions in combination with pharmacological therapy	2 (2.1%)	[2, 58]
	Intervention provider		
	Sport instructors	32 (34.0%)	[2, 4, 5, 6, 7, 9#, 11, 13#, 15, 18, 19#, 21, 25, 28, 29, 42, 45#, 50#, 64, 65, 69, 70, 72, 73, 75, 78, 79]
	Multidisciplinary team	11 (11.7%)	[10, 12, 22, 44, 47, 48, 57, 60#, 76]
	Nonspecific professional/ staff	6 (6.4%)	[14, 37, 49#, 62, 66]
	Trained yoga instructors	5 (5.3%)	[3, 8, 25, 39, 51]
	Unsupervised	5 (5.3%)	[15, 19, 59, 68, 77]
	Therapists	3 (3.2%)	[40, 58, 58]
	Study personnel with a background in sports education	3 (3.2%)	[1, 54, 55]
	Licensed massage therapists	2 (2.1%)	[30, 56]
	Trained facilitators	1 (1.1%)	[23]
	Consultants	1 (1.1%)	[74]
	Nurses	1 (1.1%)	[16]
	Not mentioned	24 (25.5%)	[20, 24, 32#, 33, 34, 35, 36#, 38, 41, 46#, 52, 53#, 56, 61, 63#, 67, 71, 80]

Note. [#]Study with more than one intervention group within a single study, intervention group is treated as a "study" in this tabulation. Thus, the study code column may not correspond to the total number of articles reported in the column.

Exercise sub-type

Sports

Sports interventions identified in the included studies were football, softball, and a non-specified sports activity.

Aerobic exercise

Aerobic exercise interventions identified in the included studies were power cycling, treadmill exercise, dancing, aerobic gymnastic, a mixture of walking and cycling, running, stepping, nonspecific aerobic exercise, and walking.

Structured fitness training

Structured fitness training programmes identified in the included studies were strength training, aerobic training and flexibility training, a combination of aerobic training, resistance training, flexibility training, balance training, a combination of aerobic training, flexibility training, strengthening training, and gym training.

A mixture of sports and exercise

A mixture of sports and exercise interventions identified in the included studies were soccer and circuit training, soccer or basketball and strength training, ball games with fitness training sessions, and an unspecified type of exercise administered to study participants.

Mind-body exercise

Mind-body exercise interventions in the included studies took the form of yoga, tai chi, baduanjin, qigong, wuqinxi, and a combination of tai chi, qigong, and yoga.

Videogame-based exercise

There was one study adopted videogame-based exercise (i.e., Wii Fit).

Movement therapy in combination with another modality

Movements therapies in combination with another modality identified in the included studies were movement therapy conducted along with acupoint massage, massage, games, and music.

Individualized PA tailored by interventionist

Individualised physical activity tailored by the interventionist identified in the included studies were treadmill walking with individualized exercise dosage, and non-specified exercise with individualized exercise dosage administered to study participants.

A mixture of leisure activities and exercise

Leisure activities identified in the included studies were pottery, TV games, card games, tea sessions, and other non-specific leisure activities and games. Of the five included studies that investigated a mixture of leisure activities and exercise, one study adopting leisure activities with aerobic and endurance training, one study adopted leisure activities with a combination of aerobic, stretching, and strengthening exercises, one study adopted leisure activities with aerobic exercise, one study adopted leisure activities with aerobic, stretching, and strengthening exercises, and one study adopted leisure activities with non-specific exercises.

Non-specific physical fitness training

One study investigated a non-specific form of physical fitness training.

Footnote

[i] The definition of mind-body exercise refers to traditional exercise grounded in Eastern philosophy.

[ii] The definition of aerobic exercise refers to aerobic training and indicates the continuity of the exercise.

[iii] The definition of structured fitness training refers to exercise intervention that consists of different training components, such as aerobic training and resistance training or circuit training.

[iv] The definition of a mixture of leisure activities and exercise refers to the exercise intervention carried out together with leisure activities.

[v] The definition of sports refers to all team and individual sports.

[vi] The definition of a mixture of sport and exercise refers to exercise intervention incorporating many types of sports and exercise.

[vii] The definition of a mixture of movement therapy in combination with another modality refers to exercise movement therapy conducted along with other modalities.

[viii] The definition of individualized physical activity intervention tailored by interventionists refers to interventionist-tailored physical activity intervention for participants with specific frequency and intensity.

[ix] The definition of videogame-based exercise refers to exercise intervention delivered through videogame.

a) Young adult group (aged 21-35)

Exercise type

Among the fifty-seven studies that investigated the group of young adults aged 21 to 35, the most commonly investigated type of exercise was aerobic exercise. The second most commonly investigated exercise type was mind-body exercise. The third most commonly investigated exercise type was a structured fitness training programme. Other exercise interventions examined the effect of a mixture of leisure activities and exercise, sports, movements therapy in combination with another modality, a mixture of sports and exercise, individualized physical activities tailored by an interventionist, and nonspecific physical fitness training.

Exercise subtype

Sports

The two sports intervention studies were football and a nonspecific sport.

Aerobic exercise

Aerobic exercise identified in the included studies were power cycling, treadmill exercise, dance, aerobic gymnastics, a mixture of walking, cycling, and running, stepping, and a nonspecific aerobic exercise.

Structured fitness training

Structured fitness training in the included studies were strength training, 'aerobic and flexibility training', 'aerobic, resistance, flexibility, and balance training', 'aerobic, flexibility, and strengthening training', and a study on gym training with no information on the training component.

A mixture of sports and exercise

A mixture of sports and exercises identified in the included studies were soccer or basketball and strength training.

Mind-body exercise

Of the fifteen studies on mind-body exercise, the majority took the form of yoga, followed by baduanjin, tai chi, qigong, a combination of three exercises including tai chi, qigong, and yoga, as well as wuqinxi.

Movement therapy in combination with another modality

The movement therapies identified in the included studies were conducted along with music and game.

A mixture of leisure activities and exercise

The three studies that used a mixture of leisure activities and exercise were 'adopting leisure activities with aerobic, stretching, and strengthening exercises', 'leisure activities with a combination of aerobic, stretching, and strengthening exercises', and 'leisure activities with nonspecific exercises'.

Intervention duration

The majority of studies in the young adult subgroup had an intervention duration of 9-12 weeks, followed by less than 4 weeks, while the duration of 5-8 weeks comes last.

Duration per session

The duration of each intervention session was generally less than 60 minutes, followed by 60 minutes, 61-90 minutes, and more than 90 minutes. There were five studies which did not report the duration of the intervention per session.

Exercise intervention with specific F.I.T.T. component

Of the sixteen studies provided information on the frequency, intensity, type, and time of the exercise intervention administered to study participants, thirteen studies were aerobic exercise interventions, two studies were structure fitness training interventions, and one study was mind-body exercise intervention.

Intervention supervision

Of the fifty-three studies that provided information on intervention structure, forty-seven were supervised physical exercise interventions. Five studies were self-administered interventions, and one study used a combination of supervised and unsupervised self-selected physical activity.

Intervention component

The majority of these studies used exercise exclusively as the main component of the exercise intervention. Five studies are multi-component exercise interventions. Four studies conducted exercise intervention along with health education or psychotherapy components, and one study conducted exercise intervention along with a pharmacological therapy component.

b) Female group (age 18-64)

Exercise type

Among the twenty-four studies that looked at females aged 18 to 64, the most commonly investigated type of exercise was mind-body exercise. The second most commonly investigated type of exercise was aerobic exercise. The third most commonly investigated type of exercise was movement therapy in combination with another modality. Other exercise interventions examined the effect of structured fitness training and nonspecific physical fitness training.

Exercise subtype

Aerobic exercises

Aerobic exercises identified in the included studies were dance, treadmill, aerobic gymnastics, and a nonspecific aerobic exercise.

Structured fitness training

Structured fitness training programmes identified in the included studies were aerobic training, resistance training, flexibility training, and balance training.

Mind-body exercise

Mind-body exercises identified in the included studies took the form of yoga, tai chi, and wuqinxi.

Movement therapy in combination with another modality

Movement therapies identified in the included studies were conducted along with massage, games, and music.

Non-specific physical fitness training

One study investigated a non-specific form of physical fitness training.

Intervention duration

The majority of studies in the female group had an intervention duration of 13-24 weeks, followed by 9-12 weeks, and 5-8 weeks.

Duration per session

Intervention duration in the female group usually lasted less than 60 minutes, followed by 60 minutes, 61-90 minutes, and more than 90 minutes.

Exercise intervention with specific F.I.T.T. component

Of the five studies that provided information on the frequency, intensity, type, and time of exercise intervention administered to study participants, four studies involved aerobic exercise interventions, and one study delivered a mind-body exercise intervention.

Intervention supervision

Of the twenty-three studies that provided information on intervention structure, twenty-one of them were supervised physical exercise interventions. One study used a combination of supervised and unsupervised self-selected physical activity. One study used self-administered interventions.

Intervention component

Twenty studies used exercise as the primary component of the exercise intervention. Four studies adopted multi-component exercise interventions, which involved using exercise interventions along with health education or psychotherapy components.

3.5 Objective 2: To identify existing outcome measures for use in the evaluation of physical exercise intervention for drug-dependent group in the current literature

The current review identified a total of 62 outcomes and 184 related instruments used in evaluating physical exercise intervention for the drug-dependent group. The interdisciplinary scientific committee categorize these outcomes into ten major outcomes. They are a) physical and physiological outcomes; b) behavioural outcomes; c) clinical or health outcomes; d) neurological or cognitive outcomes; e) psychological outcomes; f) sleep outcomes; g) substance-use outcomes; h) quality of life outcomes; i) social outcomes and j) multi-dimensional outcomes. Table 7 lists all the outcomes and the related measurement instruments used to measure the outcomes.

Apart from outcomes related to the effects of exercise intervention, some included studies also measured parameters related to the process evaluation and feasibility outcomes of the exercise interventions. Table 8 lists all the process evaluation and feasibility outcomes.

Table 7. Outcomes and related measurement instrument

Outcomes	Instruments/ Name of the test [Studies' code]
Physical and Physiological	
Upper body strength	Grip Dynamometer [1, 7, 29, 35] Push-Up Test [35, 65, 75] 1-RM chest press [21]
Lower body strength	Chair Stand Test (CST) [70] Hack squat [62] Plantar flexion test [62] 1-RM leg press [21]
Abdominal strength	1-min sit-up test [45, 75] Partial curl-up test [65]
Body composition	Weight (weight scale) [7, 10, 21, 64, 74]

	Body Mass Index [7, 28, 29, 73] Height (Stadiometer) [2, 11, 21] Body fat percentage Bioelectrical impedance analyzer [11] 3-site caliper test [19, 64, 74]
Flexibility	Sit-and-reach test [7, 29, 35, 46, 57, 65, 74]
Mobility and balance	Timed Up and Go Test (TUG) [70]
Balance	One-leg stand with eyes closed [7, 28, 29, 46, 57]
Functional ability	The Floor Transfer Test [35]
Cardiorespiratory fitness	Sub-maximal treadmill test Balke-Ware Treadmill test [64] Balke Treadmill test 73] Cortex Metamax II portable metabolic test system [24] Treadmill test without specific protocol Symptom-limited cardiopulmonary exercise test [21] Cycle ergometer test Astrand-rhyming cycle ergometer-based cardiorespiratory fitness test [52, 53] Endurance runs Progressive aerobic cardiovascular endurance run (PACER) [28, 29, 57] Walk test Six-minute walk test (6MWT) [70] Step test [10, 19, 35, 65, 75]
National Physique Determination Standards Manual (Adult Version) NPDSM-A	Health-related fitness components (body mass index, vital capacity, a step test, and grip strength) [14] Skill-related components (flexibility, balance, and selection response time) [14]
Energy expenditure	Kilocalories (kcal) [2]
Cardiac function	Heart rate variability (Polar Electro RS800CX) [10] Heart rate

	Zephyr bioharness device [36] Polar Heart Rate Monitor [73] 15-sec pulse rate check via wrist palpation [74] Polar Electro FS2C [10] Alatech ALA COACH wearable cardiometer [80]
Vital capacity	Electronic spirometer [10] Respiration (Zephyr bioharness device) [36]
Blood pressure	Systolic and diastolic blood pressure Digital sphygmomanometer [1, 7] A semiautomatic digital device [35] Auto-mated sphygmomanometer [73] Stethoscope & sphygmomanometer [74]
Bone quality	Bone mass measurement (Quantitative ultrasound device (BX-BDI-500A) [11])
Fine motor	Fine motor speed (Finger Tapping Test) [13] O'Connor Tweezer Dexterity Test [13] Automatic Mirror Tracer Model 58024A [13]
Serum level	Kynurenine (KYN) and kynurenic acid (KA) levels [50] Serum cytokine (EMD Millipore multiplex bead-based assay kit [4]) Vascular cellular adhesion molecule and cortisol (Enzyme-linked immunosorbent assays kits [4]) Blood samples (immune function, complete blood count, hepatic function, renal function) [18]
Behavioral	
Physical activity	The International Physical Activity Questionnaire, Short Form (IPAQ) [1, 2, 35] The Godin Leisure-Time Exercice Questionnaire (LTEQ) [65] Intervention Adherence assessing home yoga practice (International Physical Activity Questionnaire (IPAQ) [39]

	The International Physical Activity Questionnaire-Long Version (IPAQ-L) [2]
Locomotor activity	Locomotor activity (Zephyr bioharness device [36])
Behavioural/ emotional regulation	The Brief Self Control Scale [1, 25]
Clinical/Health	
Pain	Numeric Rating Scale [30] The Brief Pain Inventory - Pain Interference Scale (BPI-I) [39]
Somatic health burden	Somatic conditions participants suffer from out of a list of 25 conditions developed by senior researchers [72]
Striatal Dopamine D2/D3 receptor availability	Philips Gemini Tru Flight PET/CT scanner [12]
Medical condition/ medical history	Medical Symptoms Checklist (MED) [30]
Lung disease	Medical Research Council (UK) Breathlessness scale [41] Spirometry test [41] Blood oxygen level [41]
Diabetes	Blood glucose [41] Urine sugar [41] Urine protein [41]
Heart disease	New York Heart Association functional classification system (NYHA scale) [41] Electrocardiogram (classified as not normal) [41]
Depression and anxiety symptoms	Hopkins Symptoms Checklist (HSCL-25) [72]
Determination of immune function and DA level	Venous blood sample (Enzyme-linked immunosorbent assays kits) [63]
Neurological/ Cognitive	
Brain activity	Vertical electrooculogram (EOG) recording [49]

Working memory and executive functions	Stroop Color-Word Test [9, 10] WAIS-R Digit Span Task [9] Six Letter Cancellation Task [9] 2-back [10] Shift-task [10] Choice Reaction Time [46]
Attention	Dot-probe task [45] The drug Color-Word Stroop task [80]
Overall cognition	Classical stop-signal paradigm [14]
Neuromuscular measurements	Maximal voluntary contraction (V-waves) and maximal direct motor potential (M-wave) [62]
Impulsive choice	EEG recording (Brain Vision Analyzer 2.1 toolbox) [79]
Event-related potentials (N170, N2, P2, or P3 amplitudes)	Standard Go/NoGo task and MA-related Go/NoGo task [5, 52, 53]
Inhibitory control	Standard Go/NoGo task and MA-related Go/NoGo task [5, 52, 53]
Psychological	
Anxiety and depression	The German version of the Centre for Epidemiologic Studies Depression Scale [1, 29] The Beck Depression Inventory [14, 42] The Hamilton Rating Scale for Depression (HRSD) [18] Beck-2 depression inventory [61] Center of Epidemiological Studies-Depression [19] Self-rating depression scale (SDS) [47, 54, 63] Patient Health Questionnaire-9 (PHQ-9) [33, 65] 16-item Quick Inventory of Depressive Symptomatology - Clinician rated version [38] Hamilton Anxiety Rating Scale [14, 59] Spielberger State-Trait anxiety inventory [61] State-Trait Anxiety Inventory [20, 40] Hospital Anxiety & Depression Scale (HAD) [24, 25, 62]

	Self-rating anxiety scale (SAS) [47, 54, 55] Generalized Anxiety Disorder Survey (GAD-7) [33] The Beck Anxiety Inventory [42] Novaco Anger Inventory Short Form [40] Kessler 6 [65]
Emotion and expression	Positive and Negative Affect Schedule (PANAS) [30, 65] Difficulties in Emotion Regulation Scale (DERS) [30]
Stress	The Perceived Stress Scale (PSS) [1, 2, 3, 22, 23, 30, 33] Adapted version of the Posttraumatic Diagnostic Symptom Scale (PDS) [23] Modified Post-traumatic Stress Disorder Scale (MPSS) [30] PTSD Checklist-Military Version (PCL-M) [65]
Psychiatric symptoms/ Primary psychological symptoms	The Brief Symptom Inventory-18 [2, 30] Global Severity Index [8] Symptom Check List (SCL-90-R) [8] 32-item Behavior and Symptom Identification Scale (BASIS-32) [22] Eating Disorder Examination Questionnaire (EDE-Q) [30] Concise Associated Symptoms Tracking- Self-Report [38] Positive and negative syndrome scale (PANSS) [63] Dissociation Experiences Scale (DES) [30]
Food-related sensation and selection	Visual food cue paradigm (Functional near-infrared spectroscopy) [15] Oxyhemoglobin concentration (HbO) [32] Leeds Food Preference Questionnaire (LFPQ) [15] Forced-choice paradigm [15] Food stimuli [15]
Perceived exhaustion	Borg's Rating of Perceived Exertion (RPE) Scale [60, 80] Ratings of perceived exertion (Borg 6–20 scale) [52, 64]
Changes in mood state	Single-item Likert scale [60]

	Feeling scale [16] The Profile of Mood State (POMS) [33, 51] Numerical Rating Scale [39]
Attitudes towards the body	Scale of Body Connection (SBC) [30] Follow-up questionnaire [30] Body Investment Scale (BIS) [30]
Self-evaluation	Situational Confidence Questionnaire [33] 10-item Rosen-berg Self-Esteem Scale [60]
Mindfulness domain of the subjects	Freiberg Mindfulness Inventory–short form (FMI-14) [25]
Skills associated with the practice of mindfulness	Five Facet Mindfulness Questionnaire (FFMQ) [30]
Exercise beliefs	The Self-Efficacy for Exercise Scale [35] The Intrinsic Motivation Inventory [35]
Sleep	
Sleep quality	The Self-report Insomnia Severity Index [1] Insomnia Severity Index ISI [24, 62] Medical outcomes study-sleep scale (MOS-Sleep) [25] Pittsburg Sleep Quality Index (PSQI) [29, 35, 54]
Substance-use	
Substance use	Timeline Follow back Questionnaire (TLFB) [1, 2, 3, 6, 30, 33, 34, 38, 64, 65] Urine drug screens (UDS) [2, 30, 34, 36, 38, 42, 59] The alcohol use disorder identification test (AUDIT) [67] The Drug Use Disorders Identification Test (DUDIT) [67] Substance Used Inventory (SUI) [42] Structured interviews on drug or alcohol use (Qualitative) [66] Structured Clinical Interview for DSM-IV (Qualitative) [64]

	Percent days abstinent (PDA) for alcohol and drug use [64] Reasons For Drinking Questionnaire [30] Breathalyzer [30] Questionnaire on substance use history developed by research team [10]
Craving	Visual Analogue Scale (VAS) [5, 14, 15, 16, 47, 49, 52, 53, 60, 63, 80] Visual Stimuli using the Marijuana Craving Questionnaire (MCQ-SF) [6] Craving questionnaires-short form [33] Subjective measures of craving [36]
Severity of Addiction	Addiction Severity Index (ASI) [8, 23, 24] European Addiction Severity Index (EuropeASI) [72, 75] The Addiction Severity Index-Lite [38]
Withdrawal symptoms	Rating scale of heroin withdrawal symptoms [18] Protracted withdrawal symptoms (PWS) [58] The Chinese Standard Evaluation Scale of Withdrawal Symptoms [59] Stimulant Selective Severity Assessment [38]
Quality of life	
Quality of life	The 36-item short-form health survey questionnaire (SF-36) [1, 38, 41, 51, 70] EQ-5D-3L index & EQ-5D-3L visual analogue scale [73] World Health Organization Quality of Life Brief (WHOQOL-BREF [72] Quality of life for drug addicts (QOL-DA) [7, 47, 48, 56, 57] The Quality of Life Inventory [35] The Brief Life Satisfaction Scale [2] Quality of Recovery Index (QRI) [22] Quality of life scale for a drug addiction questionnaire (QOL-DA) [7, 28, 63]

	The Life Orientation Test-Revised [2]
Social	
Perceived social support	The Multidimensional Scale of Perceived Social Support (MSPSS) [65] Physical Activity Social Support scale [35]
Multi-domain	
Physical and cognitive functioning	The Massachusetts General Hospital Cognitive and Physical Functioning Questionnaire [38]

Table 8. Process evaluation and intervention feasibility outcomes

Intervention feasibility	
Attendance	Group attendance sheet [23]
Intervention satisfaction	Satisfaction Questionnaire developed by the research team [39, 58] Satisfaction Questionnaire with open-ended questions developed by the research team (Qualitative) [23] 5-point Likert scale [60] 10-point Likert scale [40]
Adverse events	Systematic Assessment of Treatment-Emergent Events – General Inquiry (SAFTEE) [39]
Intervention credibility	Credibility Expectancy Questionnaire (CEQ) [39]
Intervention feedback	Intervention Feedback Questionnaire with open-ended questions developed by the research team (Quantitative & Qualitative) [64] Checklist on teacher fidelity with scores created by research personnel [39] 4-item Likert-type scale on program acceptability developed by research personnel [2] Semi-structured interviews on program perception (Qualitative) [70]

3.6 Objective 3: To systematically synthesize the effectiveness of different types of physical exercise intervention for different drug-dependent groups (i.e., young adult/ female (mother) group) in the literature

Outcomes with sufficient data were included in this meta-analysis. A detailed list of outcomes and corresponding instruments or names of tests is presented in Table 9 in accordance with the eight predefined categories: physical and physiological, neurological or cognitive, psychological, behavioural, health, sleep, substance use, and quality-of-life outcomes.

Table 9. Outcomes with adequate evidence for meta-analysis

Outcomes	Instruments/ Name of the test [Studies' code]
Physical and Physiological	
Flexibility	Sit-and-reach test [7, 35, 57, 65, 74]
Cardiorespiratory fitness	Sub-maximal treadmill test Balke-Ware Treadmill test [64] Balke Treadmill test [73] Cortex Metamax II portable metabolic test system [24] Treadmill test without specific protocol Symptom-limited cardiopulmonary exercise test [21] Cycle ergometer test Astrand-rhyming cycle ergometer-based cardiorespiratory fitness test [52, 53] Endurance runs Progressive aerobic cardiovascular endurance run (PACER) [57] Walk test Six-minute walk test (6MWT) [70] Step test [10, 35, 65]
Blood pressure	Resting blood pressure (Stethoscope & sphygmomanometer) [74] Systolic and diastolic blood pressure Digital sphygmomanometer [1, 7]

	A semiautomatic digital device [35] Auto-mated sphygmomanometer [73]
Neurological or cognitive outcomes	
Inhibitory control	Standard Go/NoGo task and MA-related Go/NoGo task [5, 52, 53]
Event-related potentials (N2 amplitudes)	Standard Go/NoGo task and MA-related Go/NoGo task [5, 52, 53]
Working memory and executive functions	Stroop Color-Word Test [9, 10] WAIS-R Digit Span Task [9] Six Letter Cancellation Task [9] 2-back [10] Shift-task [10]
Psychological	
Anxiety	Hamilton Anxiety Rating Scale [14, 59] Generalized Anxiety Disorder Survey (GAD-7) [33] The Beck Anxiety Inventory [42] Hospital Anxiety & Depression Scale (HAD Anxiety) [24, 25, 62] State-Trait Anxiety Inventory [20] Self-rating anxiety scale (SAS) [47, 54, 55] Kessler 6 [65] Spielberger State-Trait anxiety inventory [61]
Depression	The German version of the Centre for Epidemiologic Studies Depression Scale [1] The Beck Depression Inventory [14, 42] The Hamilton Rating Scale for Depression (HRSD) [18] Beck-2 depression inventory [61] Self-rating depression scale (SDS) [47, 54, 63] Patient Health Questionnaire-9 (PHQ-9) [33, 65] Hospital Anxiety & Depression Scale (HAD Depression) [24, 25, 62]
Stress	The Perceived Stress Scale (PSS) [1, 3, 22, 23, 30, 33]
Behavioral	

Physical activity	The International Physical Activity Questionnaire, Short Form (IPAQ) [1, 2, 35] The Godin Leisure-Time Exercise Questionnaire (LTEQ) [65] Intervention Adherence assessing home yoga practice (International Physical Activity Questionnaire (IPAQ) [39] The International Physical Activity Questionnaire-Long Version (IPAQ-L) [2]
Clinical/Health	
Pain	Numeric Rating Scale [30] The Brief Pain Inventory - Pain Interference Scale (BPI-I) [39]
Sleep	
Sleep quality	The Self-report Insomnia Severity Index [1] Insomnia Severity Index ISI [24, 62] Medical outcomes study-sleep scale (MOS-Sleep) [25] Pittsburg Sleep Quality Index (PSQI) [35, 54]
Substance-use	
Substance use	Timeline Follow back Questionnaire (TLFB) [1, 3, 6, 34]
Craving	Visual Analogue Scale (VAS) [5, 14, 15, 49, 53, 60, 63, 80] Subjective measures of craving [36] Craving questionnaires-short form [33]
Quality of life	
Quality of life	The 36-item short-form health survey questionnaire (SF-36) [1, 51, 70] Quality of life for drug addicts (QOL-DA) [7, 47, 48, 56a, 56b, 57, 63a, 63b]

3.6.1 Physical and physiological outcomes

The effect of exercise interventions on flexibility

All the included studies used the sit-and reach test to quantify flexibility.

Figure 2(a) shows the five studies (codes 7, 35, 57, 65 and 74) that examined the effects of physical exercise on flexibility post-intervention. The results from a random effect model

showed a significant medium effect size on overall flexibility outcomes (SMD = 0.33 [95% CI: 0.14, 0.51], $P<0.01$, I^2 =0%).

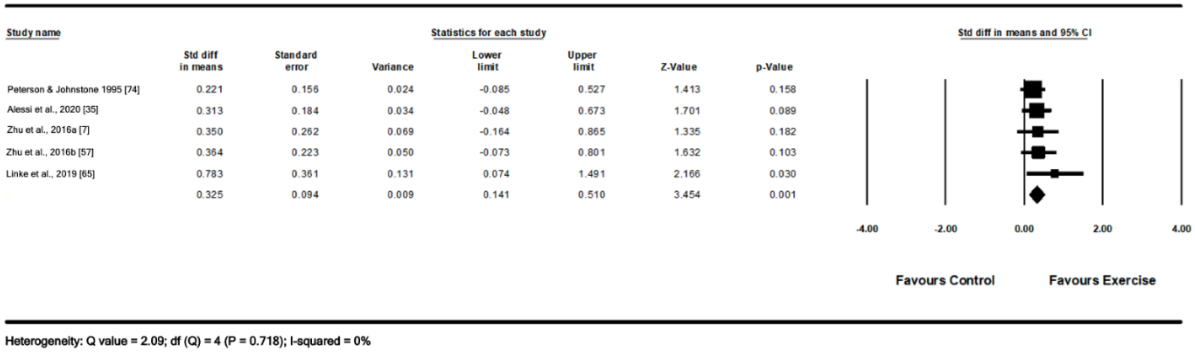


Figure 2(a). The effect of exercise interventions on flexibility at post-intervention.

The effects of exercise interventions on flexibility among female and young adults' subgroup

A larger effect was observed in the general drug-dependent population than in the female drug-dependent subgroup. The effect size was 0.39 (95% CI: 0.12 to 0.67) for the general drug-dependent population and 0.27 (95% CI: 0.02 to 0.52) for the female drug-dependent subgroup. Heterogeneity remained unchanged for both subgroup analyses, I^2 = 0% (P = 0.501) and I^2 = 0% (P = 0.599), respectively (Figure 2(b)).

A subgroup analysis on the effect of physical exercise on flexibility at post-intervention for the young adult drug-dependent subgroup was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect than a single study (Borenstein et al., 2011).

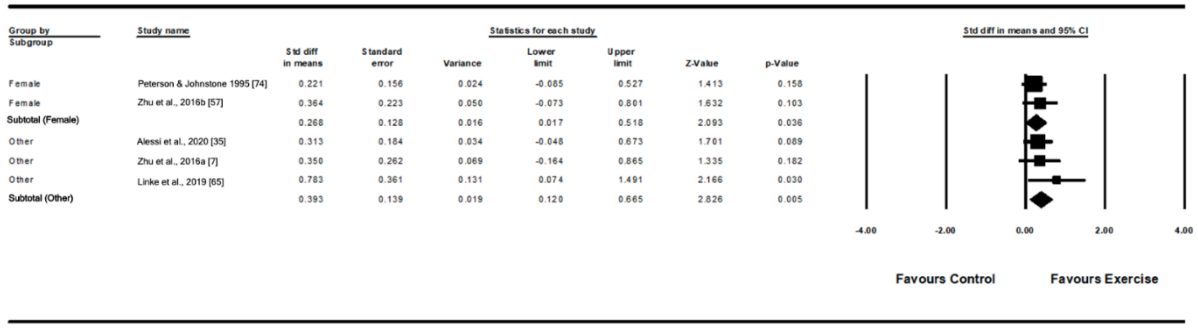


Figure 2(b). Drug-dependent subgroups analysis for the effects of exercise interventions on flexibility at post-intervention.

The effect of different types of exercise interventions on flexibility

Aerobic exercise

No significant difference was found when comparing aerobic exercise with non-exercise interventions in terms of flexibility (SMD = 0.22 [95% CI: -0.09, 0.53], $P > 0.05$, I^2 =0%).

Structured fitness training

A significant difference was found when comparing structured fitness training with non-exercise interventions, suggesting that structured fitness training improved flexibility more effectively (SMD = 0.78 [95% CI: 0.07, 1.49], $P < 0.05$, I^2 =0%).

Mind-body exercise

A significant difference was found when comparing mind-body exercise with non-exercise interventions, suggesting that mind-body exercise was more effective in improving flexibility (SMD = 0.36 [95% CI: 0.03, 0.69], $P < 0.05$, I^2 =0%).

A mixture of leisure activities and exercise

No significant difference was found when comparing a mixture of leisure activities and exercise with non-exercise interventions in improving flexibility (SMD = 0.31 [95% CI: -0.05, 0.67], $P > 0.05$, I^2 =0%).

Among the different types of exercise interventions for drug-dependent groups, structured fitness training appeared to be most effective in improving flexibility, followed by mind-body exercise, a mixture of leisure activities and exercise, and aerobic exercise.

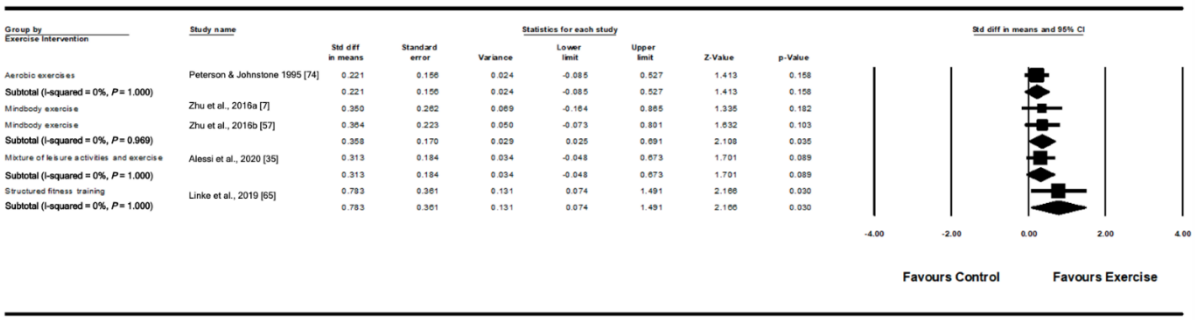


Figure 2(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on flexibility at post-intervention.

The effect of different types of exercise interventions on flexibility among female and young adults subgroup

Two studies (code 57, 74) that focused on the female drug-dependent subgroup showed a significant difference in increasing flexibility with exercise interventions compared with non-exercise interventions (SMD = 0.27 [95% CI: 0.02, 0.52], $P < 0.05$, I^2 =0%; Figure 2(d)). Subgroup analysis indicated that mind-body exercise (0.36 (95% CI: -0.07 to 0.80)) is superior to aerobic exercise (0.22 (95% CI: -0.09 to 0.53)) for the female drug-dependent subgroup in improving flexibility.

A subgroup analysis focused on the young adult drug-dependent subgroup on the effect of physical exercise on flexibility at post-intervention was unavailable because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

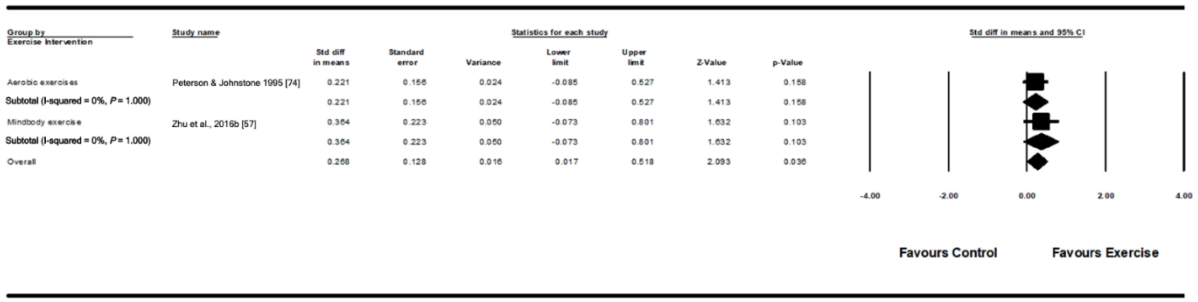


Figure 2(d). Subgroup analysis of different types of exercise interventions for female drug-dependent subgroup on flexibility at post-intervention.

The effect of exercise interventions on cardiorespiratory fitness

The included studies used various tools to quantify cardiorespiratory fitness: the 3-min step test (measured in heart rate) [code 10, 35, 65], the progressive aerobic cardiovascular endurance run (PACER) (measured in laps) [code 57], the cycle ergometer test (measured in heart rate) [code 52, 53(i), 53(ii), 53(iii)], the treadmill test (measured in Vo2max. or metabolic equivalents) [code 21, 24, 64, and 73], and the 6-min walk test (6MWT) (measured in meter) [code 70].

Figure 3(a) shows thirteen studies (code 10, 21, 24, 35, 52, 53(i), 53(ii), 53(iii), 57, 64, 65, 70, 73) that examined the effects of exercise interventions on cardiorespiratory fitness at post-intervention. The results from a random effect model showed a significantly large effect size on overall cardiorespiratory fitness outcomes (SMD = 0.93 [95% CI: 0.50, 1.36], P<.001, I^2 =87.8%).

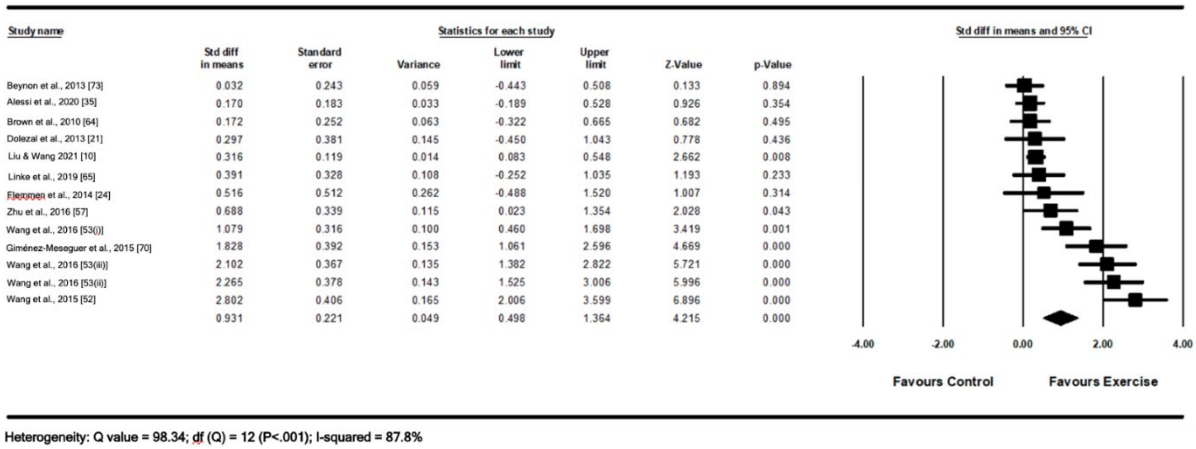


Figure 3(a). The effect of exercise interventions on cardiorespiratory fitness at post-intervention.

The effect of exercise interventions on cardiorespiratory fitness among female and young adults' subgroup

A more significant effect was observed in the young adult drug-dependent subgroup than in the female drug-dependent subgroup and the general drug-dependent population. The effect size was 1.33 (95% CI: 0.54 to 2.12) for the young adult drug-dependent subgroup, 0.69 (95% CI: 0.02 to 1.35) for the female drug-dependent subgroup, and 0.45 (95% CI: -

0.34 to 0.93) for the general drug-dependent population. Heterogeneity varied between subgroups. Young adult drug-dependent subgroup increased to I^2 = 91.6% (P <.001), whereas the female drug-dependent subgroup and the general drug-dependent population decreased to I^2 = 0% (P = 1.000) and I^2 = 76.9% (P = 0.002), respectively (Figure 3(b)).

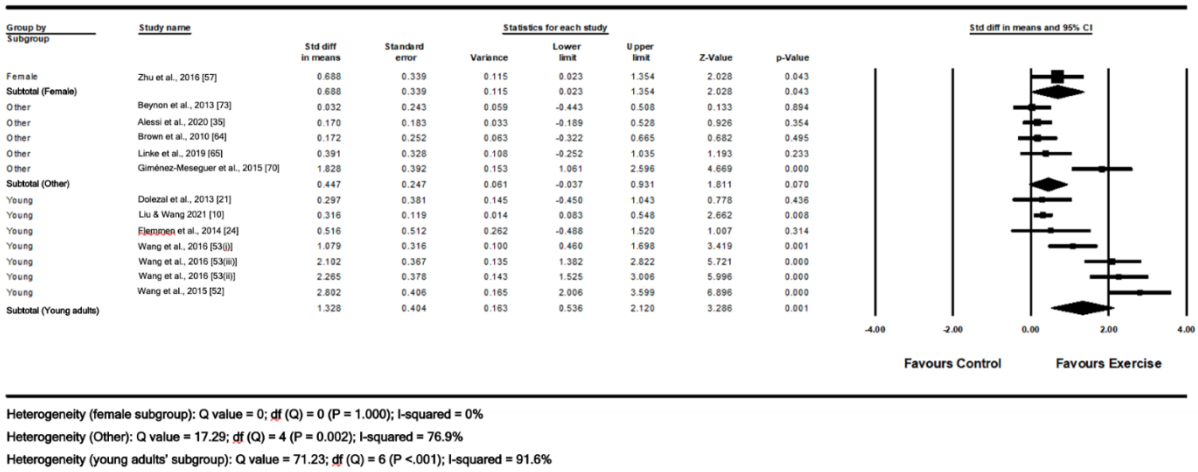


Figure 3(b). Drug-dependent subgroups analysis for the effects of exercise interventions on cardiorespiratory fitness at post-intervention.

The effect of different types of exercise interventions on cardiorespiratory fitness

Aerobic exercise

A significant difference was found when comparing aerobic exercise with non-exercise interventions in terms of cardiorespiratory fitness (SMD = 1.41 [95% CI: 0.57, 2.25], P < 0.05, I^2 =93.3%), suggesting that aerobic exercise was more effective in improving cardiorespiratory fitness.

Structured fitness training

No significant difference was found when comparing structured fitness training with non-exercise interventions in improving cardiorespiratory fitness (SMD = 0.19 [95% CI: -0.15, 0.53], P > 0.05, I^2 =0%).

Mind-body exercise

A significant difference was found when comparing mind-body exercise and non-exercise intervention, suggesting that mind-body exercise was more effective in improving cardiorespiratory fitness (SMD = 0.69 [95% CI: 0.02, 1.35], P < 0.05, I^2 =0%).

A mixture of leisure activities and exercise

No significant difference was found when a mixture of leisure activities and exercise was compared with non-exercise interventions in improving cardiorespiratory fitness (SMD = 0.82 [95% CI: -0.26, 1.89], $P > 0.05$, I^2 =86.4%).

Among the different types of exercise interventions for drug-dependent groups, aerobic exercise appeared to be most effective in improving cardiorespiratory fitness, followed by a mixture of leisure activities and exercise, mind-body exercise, and structured fitness training.

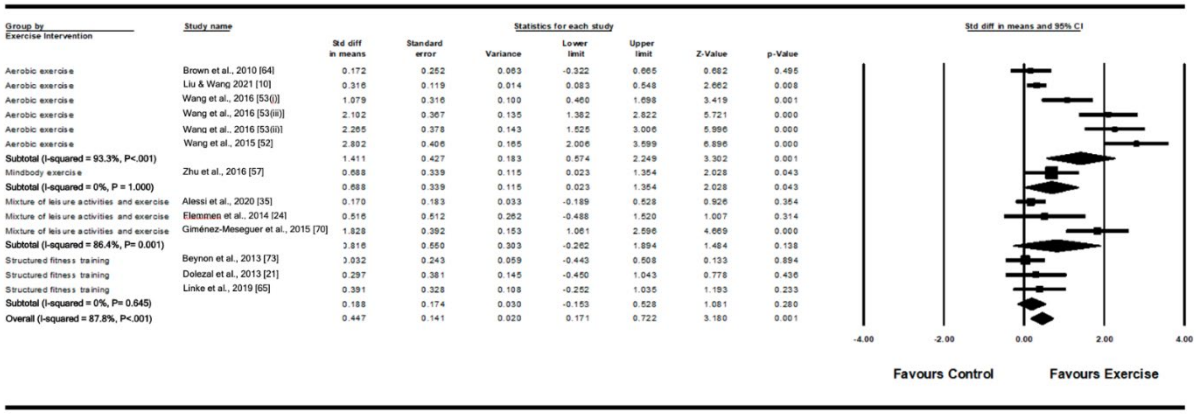


Figure 3(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on cardiorespiratory fitness at post-intervention.

The effect of different types of exercise interventions on cardiorespiratory fitness among female and young adults' subgroup

Seven studies (code 10, 21, 24, 52, 53(i), 53(ii), 53(iii)) that focused on the young adult drug-dependent subgroup showed a significant difference in improving cardiorespiratory fitness with exercise interventions compared with non-exercise

interventions (SMD = 0.70 [95% CI: 0.18, 1.22], $P < 0.05$, I^2 =0%; Figure 3(d)). Subgroup analysis indicated that aerobic exercise (SMD = 1.68 [95% CI: 0.63 to 2.73], P<0.05, I^2 = 94.2%) is superior to a mixture of leisure activities and exercise (SMD = 0.52 [95% CI: -0.49 to 1.52], P>0.05, I^2 =0) and structured fitness training (SMD = 0.30 [95% CI: -0.45 to 1.04], P>0.05, I^2 =0) for the young adult drug-dependent subgroup in improving cardiorespiratory fitness.

A subgroup analysis focused on the female drug-dependent subgroup on the effect of physical exercise on cardiorespiratory fitness at post-intervention was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

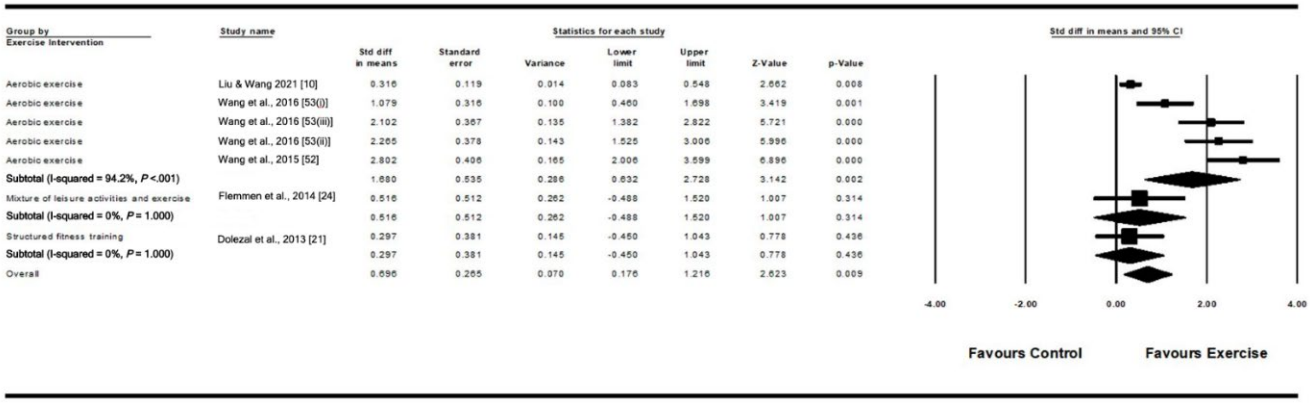


Figure 3(d). Subgroup analysis of different types of exercise interventions for young adult drug-dependent subgroup on cardiorespiratory fitness at post-intervention.

The effect of exercise interventions on blood pressure

The included studies (codes 1, 7, 35, 73 and 74) used the systolic blood pressure (measured in millimeters of mercury (mmHg) and the diastolic blood pressure (measured in mmHg) to quantify blood pressure.

Figure 4(a) shows the five studies (codes 1, 7, 35, 73 and 74) that examined the effects of physical exercise on blood pressure at post-intervention. The results from a random effect model showed a significant small effect size on overall blood pressure outcomes (SMD = 0.18 [95% CI: 0.04, 0.32], P<0.05, I^2 =0%).

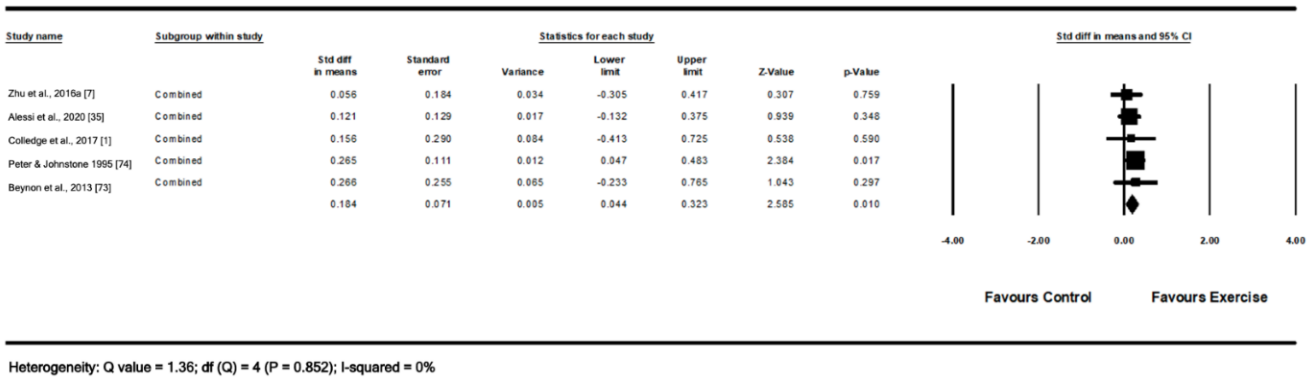


Figure 4(a). The effect of exercise interventions on blood pressure at post-intervention.

The effect of exercise interventions on blood pressure among female and male subgroup

A larger effect was observed in the female drug-dependent subgroup than in the general drug-dependent population. The effect size was 0.27 (95% CI: 0.05 to 0.48) for the female drug-dependent subgroup and 0.13 (95% CI: -0.05 to 0.31) for the general drug-dependent population. Heterogeneity remained unchanged for both subgroup analyses, I^2 = 0% (P = 1.000) and I^2 = 0% (P = 0.929), respectively (Figure 4(b)).

A subgroup analysis on the effect of physical exercise on blood pressure at post-intervention for the young adult drug-dependent subgroup was not available because there

were insufficient studies on this aspect to provide a more precise estimate of the true effect than a single study (Borenstein et al., 2021).

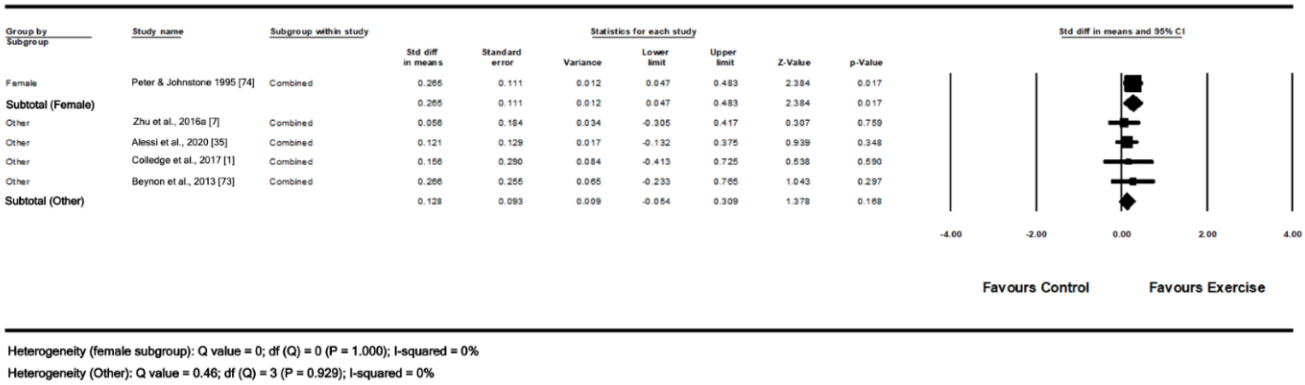


Figure 4(b). Drug-dependent subgroups analysis for the effects of exercise interventions on blood pressure at post-intervention.

The effect of different types of exercise interventions on blood pressure

Aerobic exercise

A significant difference was found when comparing aerobic exercise with non-exercise interventions in terms of blood pressure, suggesting that aerobic exercise was more effective in improving blood pressure (SMD = 0.27 [95% CI: 0.05, 0.48], $P < 0.05$, I^2 =0%).

Structured fitness training

No significant difference was found when comparing structured fitness training with non-exercise interventions in improving blood pressure (SMD = 0.27 [95% CI: -0.23, 0.77], $P > 0.05$, I^2 =0%).

Mind-body exercise

No significant difference was found when comparing mind-body exercise and non-exercise intervention in improving blood pressure (SMD = 0.06 [95% CI: -0.31, 0.42], $P > 0.05$, I^2 =0%).

A mixture of leisure activities and exercise

No significant difference was found when a mixture of leisure activities and exercise was compared with non-exercise interventions in improving blood pressure (SMD = 0.13 [95% CI: -0.10, 0.36], $P > 0.05$, I^2 =0%).

Among the different types of exercise interventions for drug-dependent groups, aerobic exercise and structured fitness training appeared to be most effective in improving blood pressure, followed by a mixture of leisure activities and exercise and mind-body exercise.

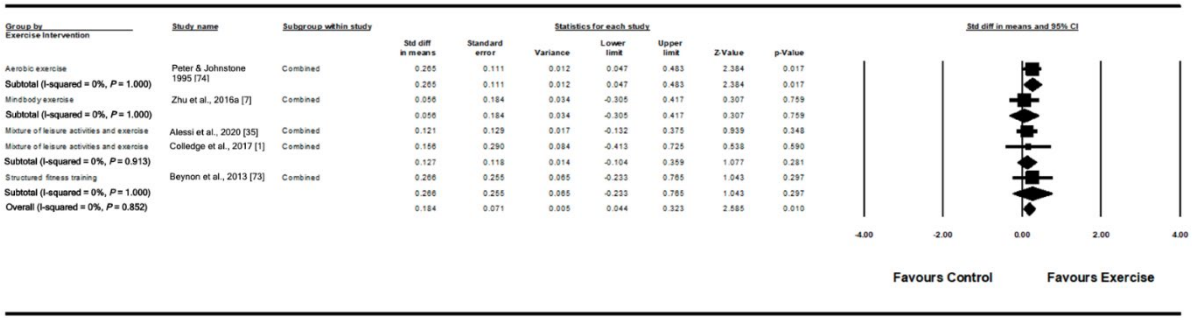


Figure 4(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on blood pressure at post-intervention.

The effect of different types of exercise interventions on blood pressure among female and young adults' subgroup

A subgroup analysis on the effect of physical exercise on blood pressure at post-intervention for the two targeted drug-dependent subgroups (female and young adult subgroups) was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

Neurological and cognitive outcomes

The effect of exercise interventions on working memory and executive functions

The included studies used five instruments to quantify working memory and executive functions: the Stroop Color-Word Test (measured in score [code 9(i) and 9(ii)] and reaction time and accuracy per milliseconds [code 10]), the WAIS-R Digit Span Task consisting of digit backward and digit forward (measured in score) [code 9(i) and 9(ii)], the Six Letter Cancellation task (measured in score) [code 9(i) and 9(ii)], the 2-Back task (measured in reaction time and accuracy per milliseconds [code 10]), and the Shift-task (measured in reaction time and accuracy per milliseconds [code 10]).

Figure 7(a) shows three studies (codes 9(i), 9(ii) and 10) that examined the effects of exercise interventions on working memory and executive functions at post-intervention. The results from a random effect model showed a significant medium to large effect size on overall working memory and executive function outcomes. (SMD = 0.57 [95% CI: 0.35, 0.78], P<0.001, I^2 =87.9%)

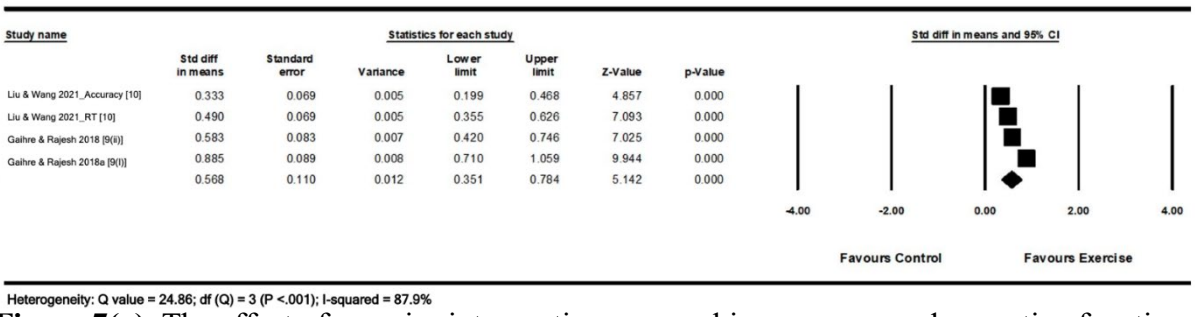


Figure 7(a). The effect of exercise interventions on working memory and executive functions at post-intervention.

The effect of exercise interventions on working memory and executive functions among female and young adults' subgroup

A medium to large effect was observed in the young adult drug-dependent subgroup. The effect size was 0.58 (95% CI: 0.45 to 0.70) for the young adult drug-dependent subgroup. Heterogeneity decreased to I^2=64.6% (P<0.001) (Figure 7(b)).

A subgroup analysis focused on the female and general drug-dependent subgroup on the effect of physical exercise on working memory and executive functions at post-intervention was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

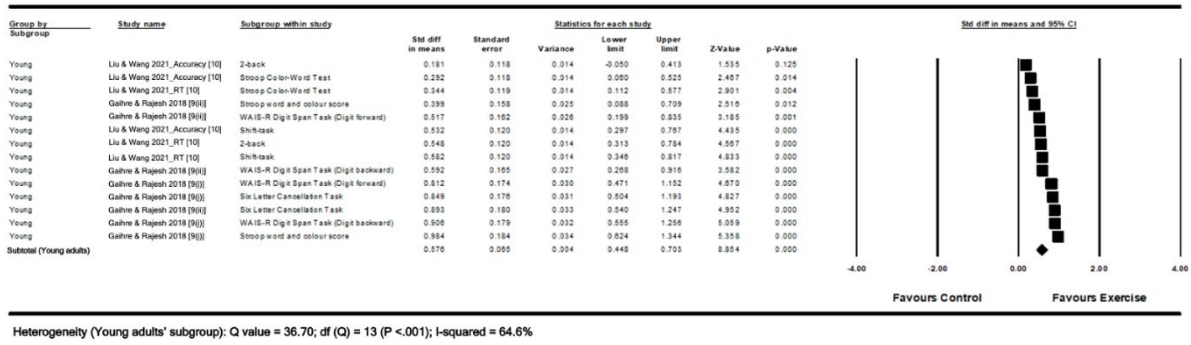


Figure 7(b). Drug-dependent subgroups analysis for the effects of exercise interventions on working memory and executive functions at post-intervention.

The effect of different types of exercise interventions on working memory and executive functions

Aerobic exercise

A significant difference was found when comparing aerobic exercise with non-exercise interventions in terms of working memory and executive functions, suggesting that aerobic exercise was more effective in improving working memory and executive functions (SMD = 0.41 [95% CI: 0.26, 0.57], P < 0.05, I^2=61.5%).

Structured fitness training

A significant difference was found when comparing structured fitness training with non-exercise interventions in terms of working memory and executive functions, suggesting that

structured fitness training was more effective in improving working memory and executive functions (SMD=0.58 [95% CI: 0.42, 0.75], $P < 0.05$, $I^2 = 0\%$).

Mind-body exercise

A significant difference was found when comparing mind-body exercise with non-exercise interventions in terms of working memory and executive functions, suggesting that mind-body exercise was more effective in improving working memory and executive functions (SMD = 0.89 [95% CI: 0.71, 1.06], $P < 0.05$, $I^2 = 0\%$).

Among the different types of exercise interventions for drug-dependent groups, mind-body exercise appeared to be the most effective type of intervention in improving working memory and executive functions, followed by structured fitness training and aerobic exercise.

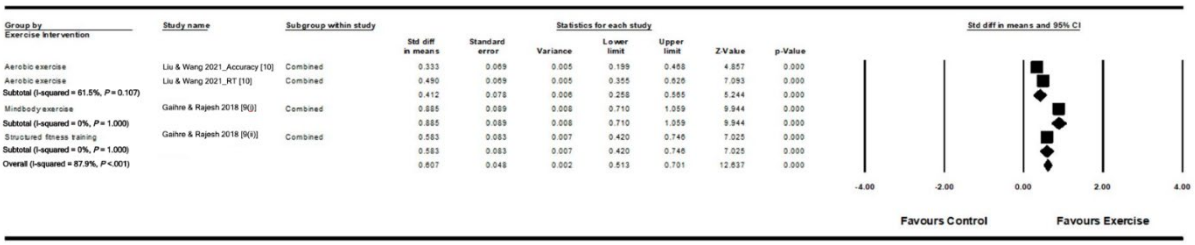


Figure 7(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on working memory and executive functions at post-intervention.

The effect of different types of exercise interventions on working memory and executive functions among female and young adults' subgroup

A subgroup analysis on the effect of physical exercise on working memory and executive functions at post-intervention for the two targeted drug-dependent subgroups (female and young adult subgroups) was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

3.6.2 Psychological outcomes

The effect of exercise interventions on anxiety

The included studies used various instruments to quantify anxiety: the Hamiton Anxiety Rating Scale [codes 14 and 59], Generalized Anxiety Disorder Survey (GAD-7) [code 33], the Beck Anxiety Inventory [code 42], Hospital Anxiety & Depression Scale (HAD Anxiety) [codes 24, 25(i), 25(ii) and 62], the Self-rating Anxiety Scale [codes 47, 54 and 55], Kessler 6 [code 65], State-Trait Anxiety Inventory [code 20], and the Spielberger State-Trait Anxiety Inventory (STAI) [code 61]. All instruments were measured with scores.

Figure 8(a) shows the fourteen studies (codes 14, 20, 24, 25(i), 25(ii), 33, 42, 47, 54, 55, 59, 61, 62 and 65) that examined the effects of physical exercise on anxiety at post-intervention. The results from a random effect model showed a significant medium to large effect size on overall anxiety outcomes (SMD = 0.51 [95% CI: 0.40, 0.61], P<.001, I^2 =0%).

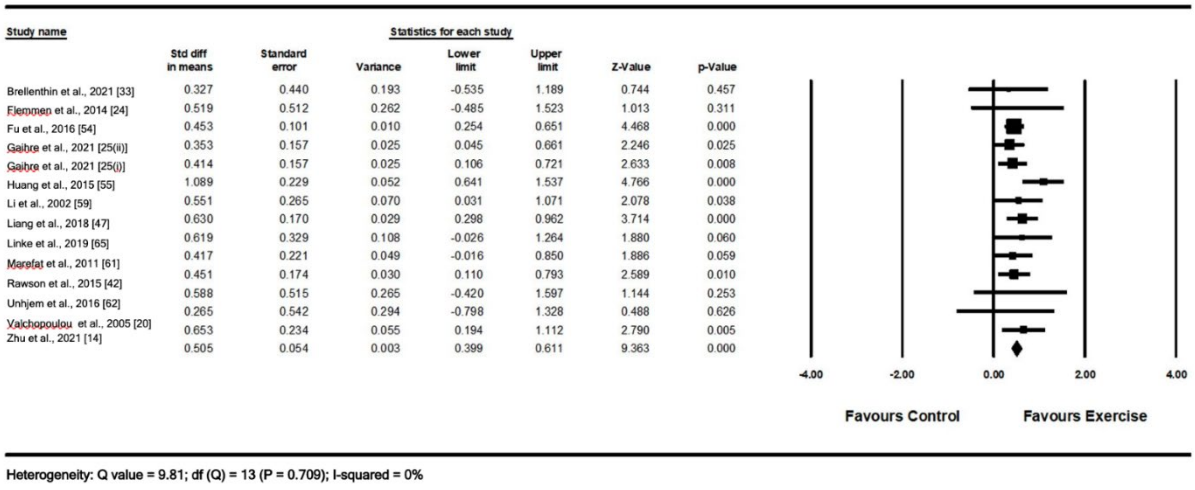


Figure 8(a). The effect of exercise interventions on anxiety at post-intervention.

The effect of exercise interventions on anxiety among female and young adults' subgroup

A more significant effect was observed in the general drug-dependent population than in the female drug-dependent subgroup and the young adult drug-dependent subgroup. The effect size was 0.91 (95% CI: 0.47 to 1.36) for the general drug-dependent population, 0.50 (95% CI: 0.26 to 0.74) for the female drug-dependent subgroup, and 0.46 (95% CI: 0.33 to

0.58) for the young adult drug-dependent subgroup. Heterogeneity varied between subgroups. The general drug-dependent population increased to I^2 = 27.5% (P = 0.240), whereas the female drug-dependent subgroup and the young adult drug-dependent subgroup decreased to I^2 = 0% (P = 0.525) and I^2 = 0% (P = 0.931), respectively (Figure 8(b)).

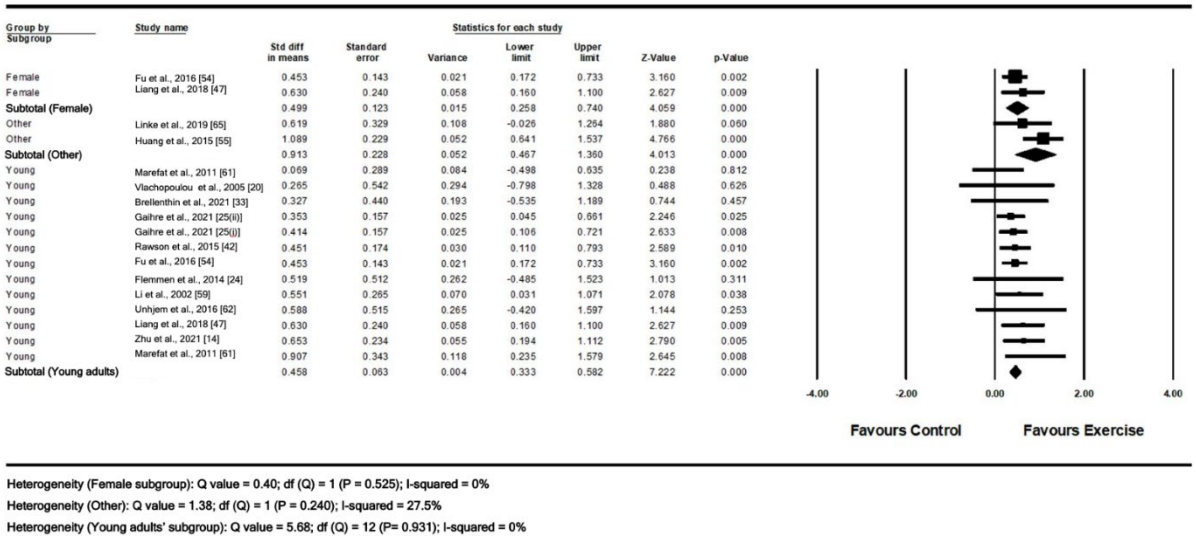


Figure 8(b). Drug-dependent subgroups analysis for the effects of exercise interventions on anxiety at post-intervention.

The effect of different types of exercise interventions on anxiety

Aerobic exercise

A significant difference was found when comparing aerobic exercise with non-exercise interventions, suggesting that aerobic exercise improved anxiety more effectively (SMD = 0.58 [95% CI: 0.18, 0.99], $P < 0.05$, I^2 =0%).

Structured fitness training

A significant difference was found when comparing structured fitness training with non-exercise interventions, suggesting that structured fitness training improved anxiety more effectively (SMD = 0.42 [95% CI: 0.20, 0.63], $P < 0.05$, I^2 =0%).

Mind-body exercise

A significant difference was found when comparing mind-body exercise with non-exercise interventions, suggesting that mind-body exercise was more effective in improving anxiety (SMD = 0.56 [95% CI: 0.38, 0.73], $P < 0.05$, I^2 =35.4%).

A mixture of leisure activities and exercise

No significant difference was found when comparing a mixture of leisure activities and exercise with non-exercise interventions in improving anxiety (SMD = 0.55 [95% CI: -0.16, 1.27], $P > 0.05$, I^2 =0%).

Among the different types of exercise interventions for drug-dependent groups, aerobic exercise appeared to be most effective in improving anxiety, followed by mind-body exercise, a mixture of leisure activities and exercise, and structured fitness training.

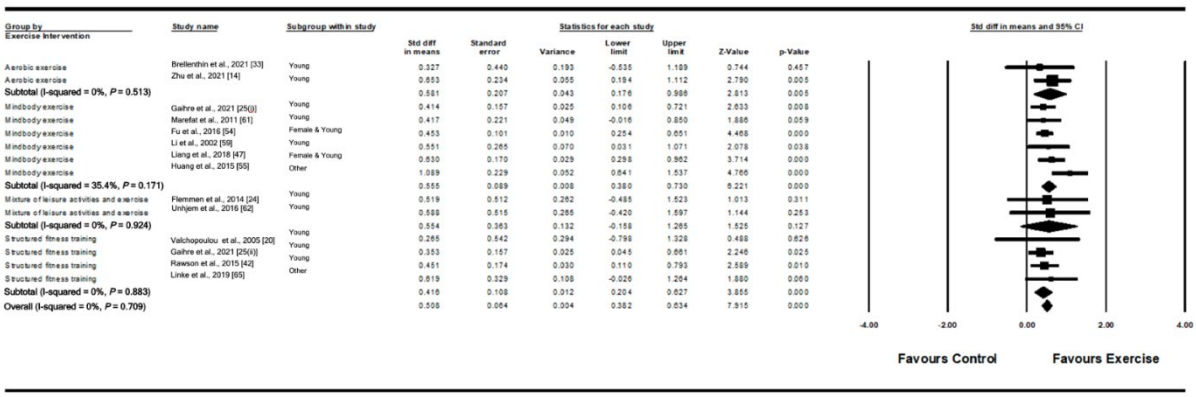


Figure 8(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on anxiety at post-intervention.

The effect of different types of exercise interventions on anxiety among female and young adults' subgroup

Twelve studies (codes 14, 20, 24, 25(i), 25(ii), 33, 42, 47, 54, 59, 61 and 62) that focused on the young adult drug-dependent subgroup showed a significant difference in improving anxiety with exercise interventions compared with non-exercise interventions (SMD = 0.46 [95% CI: 0.33 to 0.58], $P < 0.05$, I^2 =0%; Figure 8(d)). Subgroup analysis indicated that aerobic exercise (0.58 (95% CI: 0.18 to 0.99)) is superior to a mixture of

leisure activities and exercise (0.55 (95% CI: -0.16 to 1.27)), mind-body exercise (0.47 (95% CI: 0.30 to 0.63), and a structured fitness training (0.39 (95% CI: 0.17 to 0.62)) for the young adult drug-dependent subgroup in improving anxiety.

A subgroup analysis focused on the female drug-dependent subgroup on the effect of physical exercise on anxiety at post-intervention was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

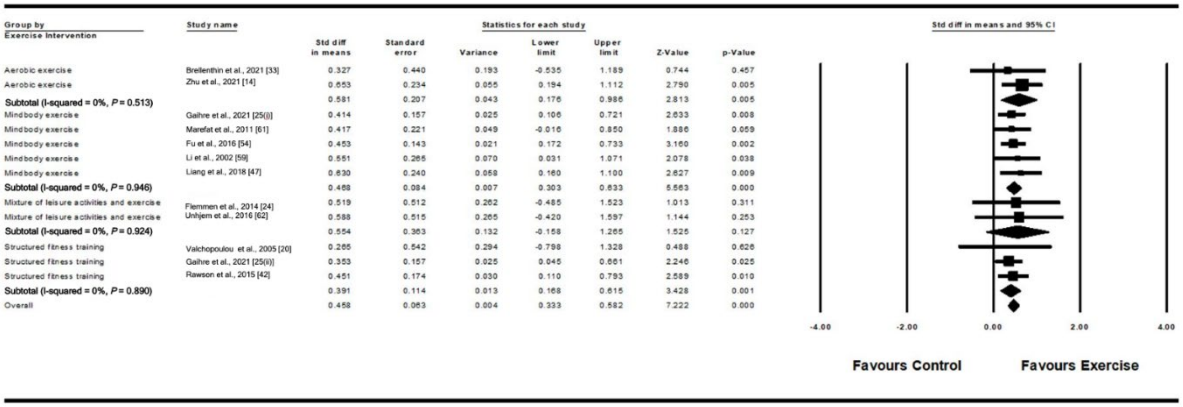


Figure 8(d). Subgroup analysis of different types of exercise interventions for young adult drug-dependent subgroup on anxiety at post-intervention.

The effect of exercise interventions on depression

The included studies used various instruments to quantify depression: the German version of the Centre for Epidemiologic Studies Depression Scale [code 1], the Beck Depression Inventory [codes 14, 42 and 61], the Hamilton Rating Scale for Depression (HRSD) [code 18], the Patient Health Questionnaire (PHQ-9) [codes 33 and 65], the Self-rating Depression Scale (SDS) [codes 47, 54, 63(i) and 63(ii)], and the Hospital Anxiety & Depression Scale (HADS Depression) [codes 24, 25(i), 25(ii) and 62]. All instruments were measured with scores.

Figure 9(a) shows the fifteen studies (codes 1, 14, 18, 24, 25(i), 25(ii), 33, 42, 47, 54, 61, 62, 63(i), 63(ii) and 65) that examined the effects of physical exercise on depression at post-intervention. The results from a random effect model showed a significant medium to

large effect size on overall depression outcomes (SMD = 0.62 [95% CI: 0.39, 0.84], *P*<.001, I^2 =72.1%).

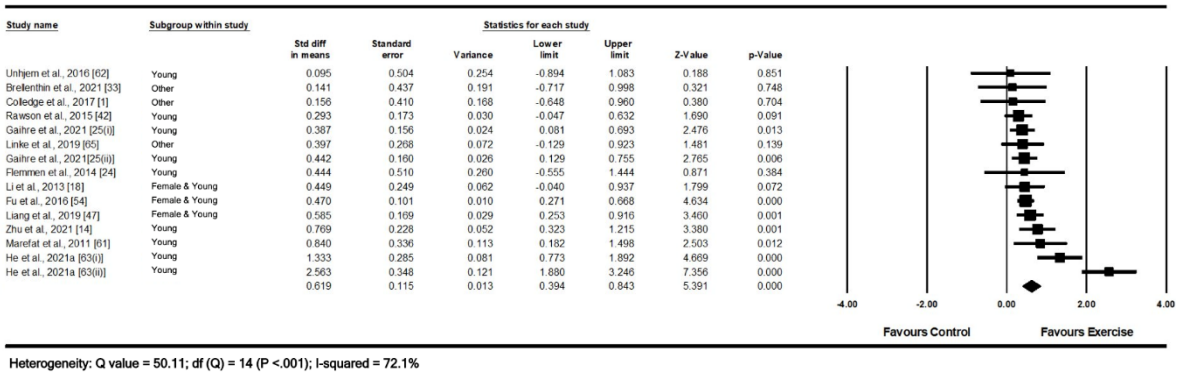


Figure 9(a). The effect of exercise interventions on depression at post-intervention.

The effect of exercise interventions on depression among female and young adults subgroup

A more significant effect was observed in the young adult drug-dependent subgroup than in the female drug-dependent subgroup and the general drug-dependent population. The effect size was 0.70 (95% CI: 0.42 to 0.99) for the young adult drug-dependent subgroup, 0.50 (95% CI: 0.27 to 0.72)) for the female drug-dependent subgroup, and 0.29 (95% CI: -0.11 to 0.68) for the general drug-dependent population. Heterogeneity varied between subgroups. Young adult drug-dependent subgroup increased to I^2 = 76.8% (*P* <.001), whereas the female drug-dependent subgroup and the general drug-dependent population decreased to I^2 = 0% (*P* = 0.910) and I^2 = 0% (*P* = 0.83), respectively (Figure 9(b)).

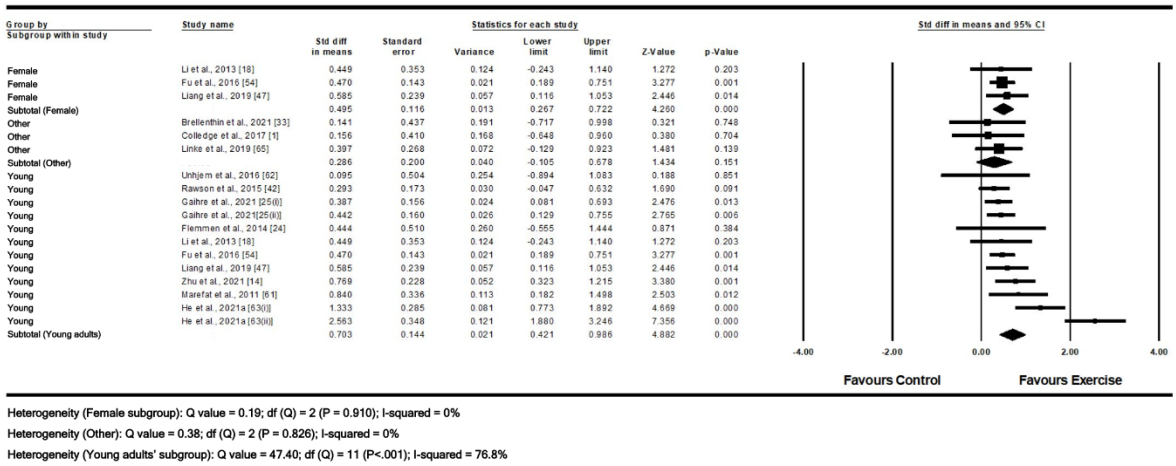


Figure 9(b). Drug-dependent subgroups analysis for the effects of exercise interventions on depression at post-intervention.

The effect of different types of exercise interventions on depression

Aerobic exercise

A significant difference was found when comparing aerobic exercise with non-exercise interventions, suggesting that aerobic exercise improved depression more effectively (SMD = 0.57 [95% CI: -0.01, 1.14], $P < 0.05$, I^2 =38.5%).

Structured fitness training

A significant difference was found when comparing structured fitness training with non-exercise interventions, suggesting that structured fitness training improved depression more effectively (SMD = 0.85 [95% CI: 0.25, 1.44], $P < 0.05$, I^2 =88.6%).

Mind-body exercise

A significant difference was found when comparing mind-body exercise with non-exercise interventions, suggesting that mind-body exercise was more effective in improving depression (SMD = 0.49 [95% CI: 0.35, 0.63], $P < 0.05$, I^2 =0%).

A mixture of leisure activities and exercise

No significant difference was found when comparing a mixture of leisure activities and exercise with non-exercise interventions in improving depression (SMD = 0.44 [95% CI: -0.56, 1.44], $P > 0.05$, I^2 =0%).

A mixture of sport and exercise

No significant difference was found when comparing a mixture of sport and exercise with non-exercise interventions in improving depression (SMD = 0.16 [95% CI: -0.65, 0.96], $P > 0.05$, I^2 =0%).

Among the different types of exercise interventions for drug-dependent groups, structured fitness training appeared to be most effective in improving depression, followed by aerobic exercise, mind-body exercise, a mixture of leisure activities and exercise, and a mixture of sport and exercise.

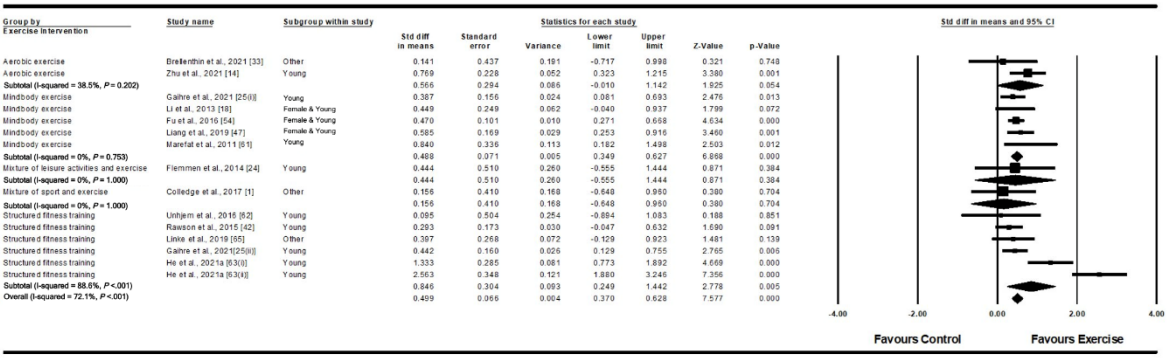


Figure 9(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on depression at post-intervention.

The effect of different types of exercise interventions on depression among female and young adults subgroup

Twelve studies (codes 14, 18, 24, 25(i), 25(ii), 42, 47, 54, 61, 62, 63i and 63(ii)) that focused on the young adult drug-dependent subgroup showed a significant difference in improving depression with exercise interventions compared with non-exercise interventions

(SMD = 0.54 [95% CI: 0.38 to 0.70], $P < 0.05$, I^2 =76.8%; Figure 9(d)). Subgroup analysis indicated that structured fitness training (0.94 (95% CI: 0.22 to 1.66)) is superior to aerobic exercise (0.77 (95% CI: 0.32 to 1.22)), mind-body exercise (0.48 (95% CI: 0.31 to 0.66)), and a mixture of leisure activities and exercise (0.44 (95% CI: -0.56 to 1.44)) for the young adult drug-dependent subgroup in improving depression.

A subgroup analysis focused on the female drug-dependent subgroup on the effect of physical exercise on depression at post-intervention was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

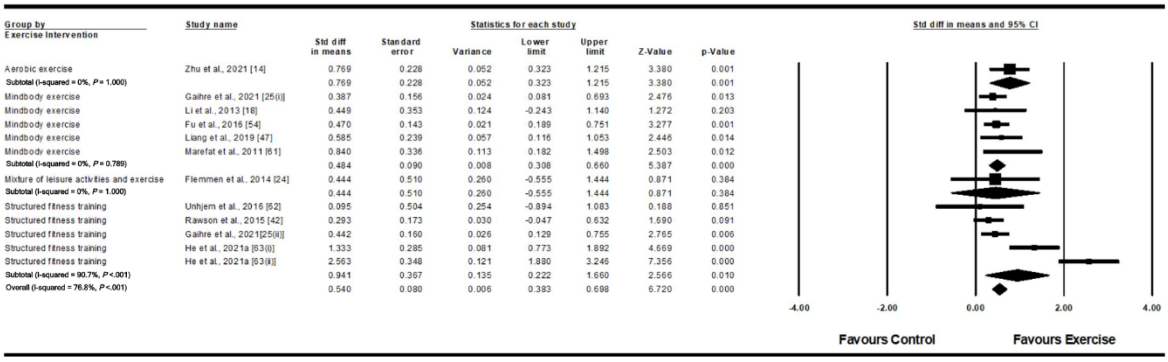


Figure 9(d). Subgroup analysis of different types of exercise interventions for young adult drug-dependent subgroup on depression at post-intervention.

The effect of exercise interventions on stress

The included studies used the Perceived Stress Scale (PSS) to quantify stress (measured with scores) [codes 1, 3, 22, 23, 30 and 33].

Figure 10(a) shows six studies (codes 1, 3, 22, 23, 30 and 33) that examined the effects of exercise interventions on stress at post-intervention. The results from a random effect model showed a significant medium effect size on overall stress outcomes (SMD = 0.32 [95% CI: 0.06, 0.58], P<0.05, I^2 =0%).

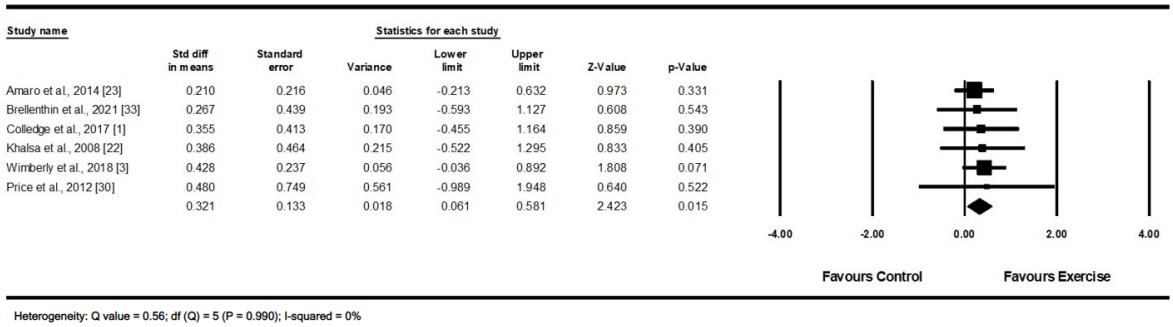
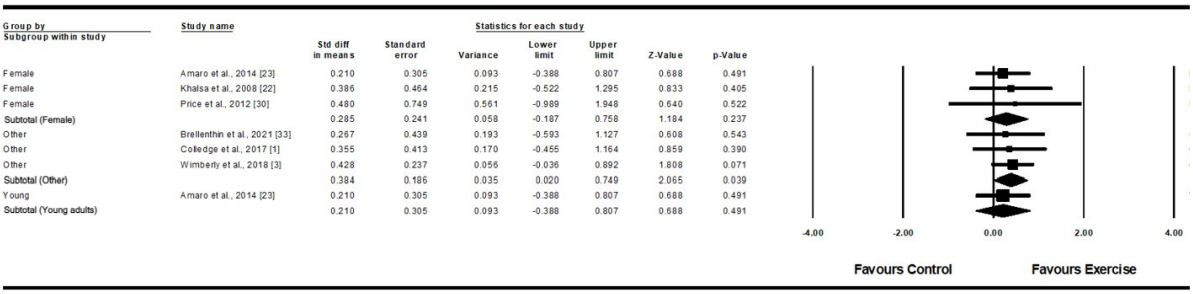


Figure 10(a). The effect of exercise interventions on stress at post-intervention.

The effect of exercise interventions on stress among female and young adults' subgroup

A more significant effect was observed in the general drug-dependent population than in the female drug-dependent subgroup and the young adult drug-dependent subgroup. The effect size was 0.38 (95% CI: 0.02 to 0.75) for the general drug-dependent population, 0.29 (95% CI: -0.19 to 0.76) for the female drug-dependent subgroup, and 0.21 (95% CI: -0.39 to 0.81) for the young adult drug-dependent subgroup. Heterogeneity remained unchanged in subgroups of the general drug-dependent population, female and young adult drug-dependent subgroups, with I^2 = 0% (P = 0.946), I^2 = 0% (P = 0.916) and I^2 = 0% (P = 1.0000) respectively (Figure 10(b)).



Heterogeneity (Female): Q value = 0.18 df (Q) = 2 (P = 0.916); I-squared = 0%
Heterogeneity (Other): Q value = 0.11; df (Q) = 2 (P = 0.946); I-squared = 0%
Heterogeneity (Young adults' subgroup): Q value = 0; df (Q) = 0 (P = 1.000); I-squared = 0%

Figure 10(b). Drug-dependent subgroups analysis for the effects of exercise interventions on stress at post-intervention.

The effect of different types of exercise interventions on stress

Aerobic exercise

No significant difference was found when comparing aerobic exercise with non-exercise interventions in improving stress (SMD = 0.25 [95% CI: -0.61, 1.11], $P > 0.05$, I^2 =0%).

Mind-body exercise

A significant difference was found when comparing mind-body exercise with non-exercise interventions, suggesting that mind-body exercise was more effective in improving stress (SMD = 0.32 [95% CI: 0.02, 0.61], $P < 0.05$, I^2 =0%).

A mixture of sports and exercise

No significant difference was found when comparing a mixture of sports and exercise with non-exercise interventions in improving stress (SMD = 0.36 [95% CI: -0.46, 1.16], $P > 0.05$, I^2 =0%).

Movement therapy in combination with another modality

No significant difference was found when comparing movement therapy in combination with another modality with non-exercise interventions in improving stress (SMD = 0.48 [95% CI: -0.99, 1.95], $P > 0.05$, I^2 =0%).

Among the different types of exercise interventions for drug-dependent groups, movement therapy in combination with another modality appeared to be the most effective type of intervention in improving stress, followed by mixture of sports and exercise, mind-body exercise and aerobic exercise.

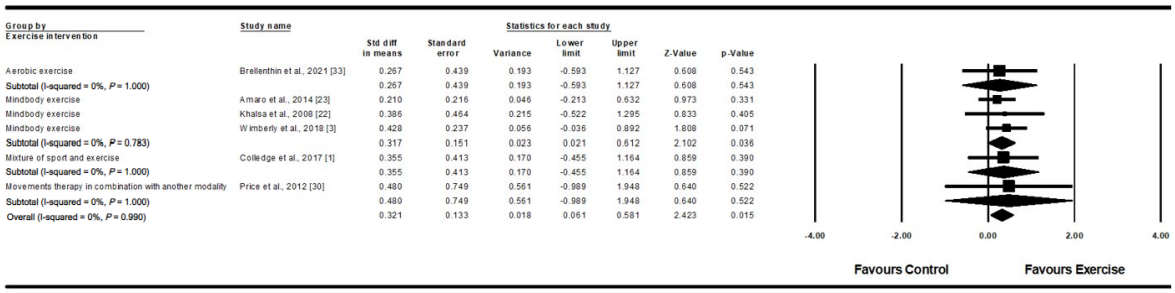


Figure 10(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on stress at post-intervention.

The effect of different types of exercise interventions on stress among female and young adults' subgroup

Three studies (codes 22, 23 and 30) that focused on the female drug-dependent subgroup showed an insignificant difference in improving stress with exercise interventions compared with non-exercise interventions (SMD = 0.29 [95% CI: -0.19 to 0.76], $P > 0.05$, I^2 =0%; Figure 10(d)). Subgroup analysis indicated that movement therapy in combination with another modality (0.48 (95% CI: -0.99 to 1.95)) is superior to mind-body exercise (0.26 (95% CI: -0.24 to 0.76)) for the female drug-dependent subgroup in improving stress.

A subgroup analysis focused on the young adult drug-dependent subgroup on the effect of physical exercise on stress at post-intervention was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

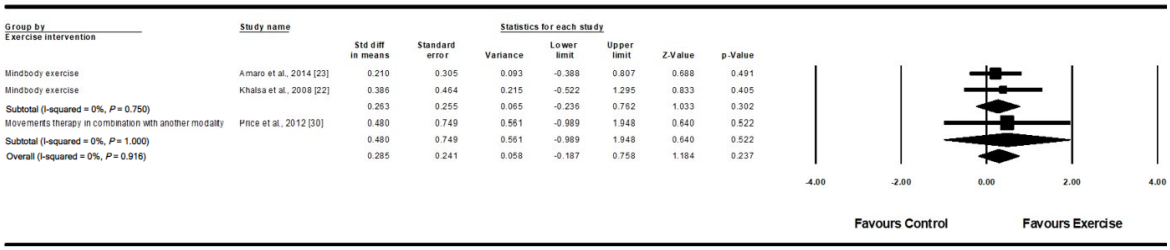


Figure 10(d). Subgroup analysis of different types of exercise interventions for female drug-dependent subgroup on stress at post-intervention.

3.6.3 Behavioral outcomes

The effect of exercise interventions on physical activity behavior

The included studies used three instruments to quantify physical activity: the International Physical Activity Questionnaire (IPAQ) (measured in hours per week, days per week (moderate/vigorous), minutes per week (walk)) [codes 1, 2 and 35], the modified version of the International Physical Activity Questionnaire (modified-IPAQ) (measured in times per week (practicing exercise intervention per week) and minutes per week (practicing exercise intervention per week) [code 39], and the Godin Leisure Exercise Questionnaire (LTEQ) (measured in metabolic equivalent per week) [code 65].

Figure 11(a) shows five studies (codes 1, 2, 35, 39 and 65) that examined the effects of exercise interventions on physical activity at post-intervention. The results from a random effect model showed a significant medium to large effect size on overall physical activity outcomes (SMD = 0.51 [95% CI: 0.20, 0.81], P<0.01, I^2 =56.2%).

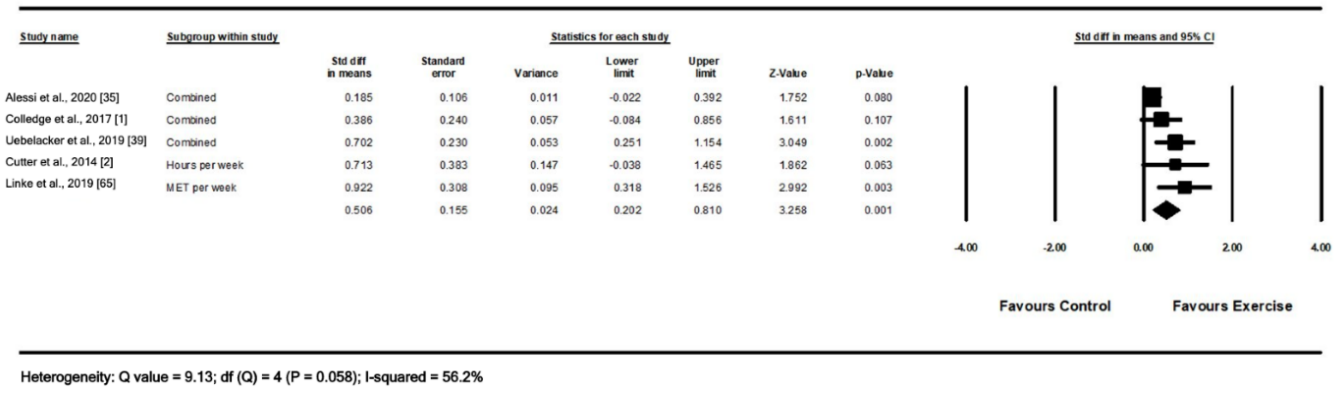


Figure 11(a). The effect of exercise interventions on physical activity at post-intervention.

The effect of exercise interventions on physical activity behavior among female and young adults' subgroup

A subgroup analysis on the effect of physical exercise on physical activity at post-intervention for the two targeted drug-dependent subgroups (female and young adults) was

unavailable because the included studies on physical activity focused mainly on the general drug-dependent population.

The effect of different types of exercise interventions on physical activity behavior

Structured fitness training

A significant difference was found when comparing structured fitness training with non-exercise interventions, suggesting that structured fitness training was more effective in improving physical activity (SMD = 0.92 [95% CI: 0.32, 1.53], $P < 0.05$, I^2 =0%).

Mind-body exercise

A significant difference was found when comparing mind-body exercise and non-exercise interventions, suggesting that mind-body exercise was more effective in improving physical activity (SMD = 0.70 [95% CI: 0.25, 1.15], $P < 0.05$, I^2 =0%).

A mixture of leisure activities and exercise

No significant difference was found when a mixture of leisure activities and exercise was compared with non-exercise interventions in improving physical activity (SMD = 0.19 [95% CI: -0.02, 0.39], $P > 0.05$, I^2 =0%).

A mixture of sport and exercise

No significant difference was found when a mixture of leisure activities and exercise was compared with non-exercise interventions in improving physical activity (SMD = 0.39 [95% CI: -0.08, 0.86], $P > 0.05$, I^2 =0%).

Videogame-based exercise

No significant difference was found when a mixture of leisure activities and exercise was compared with non-exercise interventions in improving physical activity (SMD = 0.71 [95% CI: -0.04, 1.47], $P > 0.05$, I^2 =0%).

Among the different types of exercise interventions for drug-dependent groups, structured fitness training appeared to be most effective in improving physical activity, followed by videogame-based exercise, mind-body exercise, a mixture of sport and exercise, and a mixture of leisure activities and exercise.

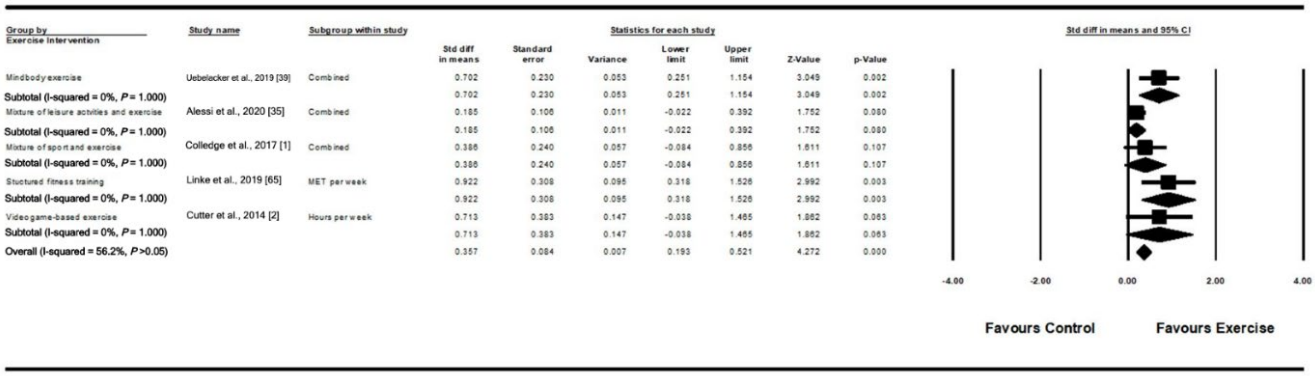


Figure 11(b). Subgroup analysis of different types of exercise interventions for drug-dependent groups on physical activity at post-intervention.

The effect of different types of exercise interventions on physical activity behavior among female and young adults' subgroup

A subgroup analysis on the effect of physical exercise on physical activity at post-intervention for the two targeted drug-dependent subgroups (female and young adult subgroups) was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

3.6.4 Health outcome

The effect of exercise interventions on pain

The included studies used two measurements to quantify pain: the Numeric Rating Scale [code 30] and the Brief Pain Inventory - Pain Interference Scale (BPI-I) [code 39]. Both instruments were measured with scores.

Figure 12(a) shows the two studies (codes 30 and 39) that examined the effects of physical exercise on pain at post-intervention. The results from a random effect model showed an insignificant small effect size on overall pain outcomes (SMD = 0.16 [95% CI: -0.28, 0.60], P>0.05, I^2 =0%).

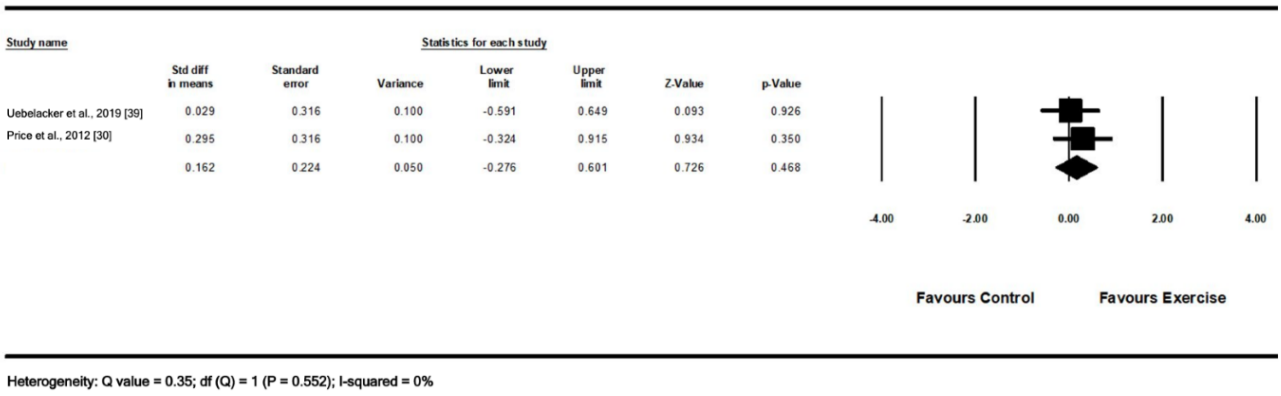


Figure 12(a). The effect of exercise interventions on pain at post-intervention.

The effect of exercise interventions on pain among female and young adults' subgroup

A larger effect was observed in the female drug-dependent subgroup than in the general drug-dependent population. The effect size was 0.30 (95% CI: -0.32 to 0.92) for the female drug-dependent subgroup and 0.03 (95% CI: -0.59 to 0.65) for the general drug-dependent population. Heterogeneity remained unchanged for both subgroup analyses, I^2 = 0% (P = 1.000) and I^2 = 0% (P = 1.000), respectively (Figure 12(b)).

A subgroup analysis on the effect of physical exercise on pain at post-intervention for the young adult drug-dependent subgroup was not available because there were insufficient

studies on this aspect to provide a more precise estimate of the true effect than a single study (Borenstein et al., 2021).

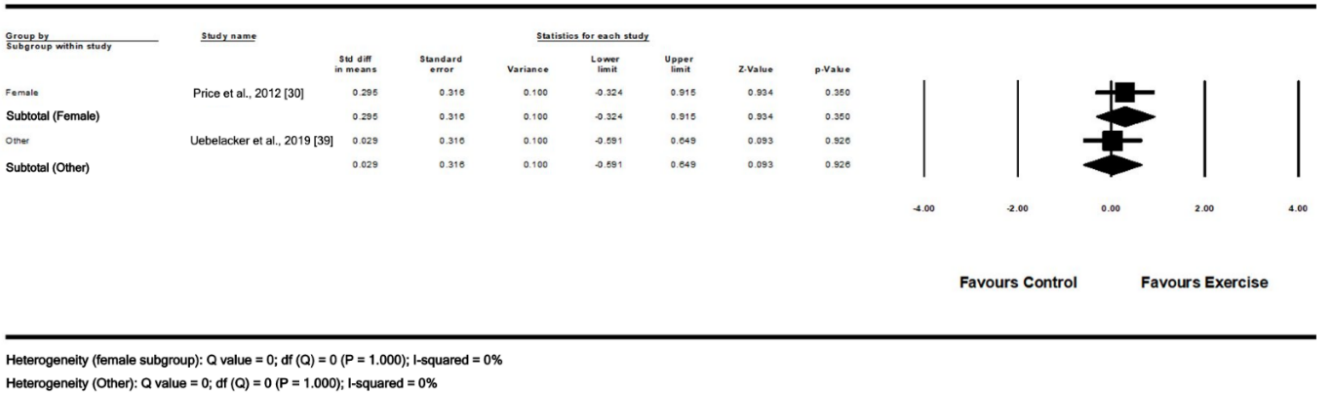


Figure 12(b). Drug-dependent subgroups analysis for the effects of exercise interventions on pain at post-intervention.

The effect of different types of exercise interventions on pain

Mind-body exercise

No significant difference was found when comparing mind-body exercise and non-exercise interventions in improving pain (SMD = 0.03 [95% CI: -0.59, 0.65], $P > 0.05$, I^2 =0%).

Movement therapy in combination with another modality

No significant difference was found when movement therapy in combination with another modality was compared with non-exercise interventions in improving pain (SMD = 0.30 [95% CI: -0.32, 0.92], $P > 0.05$, I^2 =0%).

Among the two types of exercise interventions for drug-dependent groups, movement therapy in combination with another modality appeared to be more effective than mind-body exercise in improving pain.

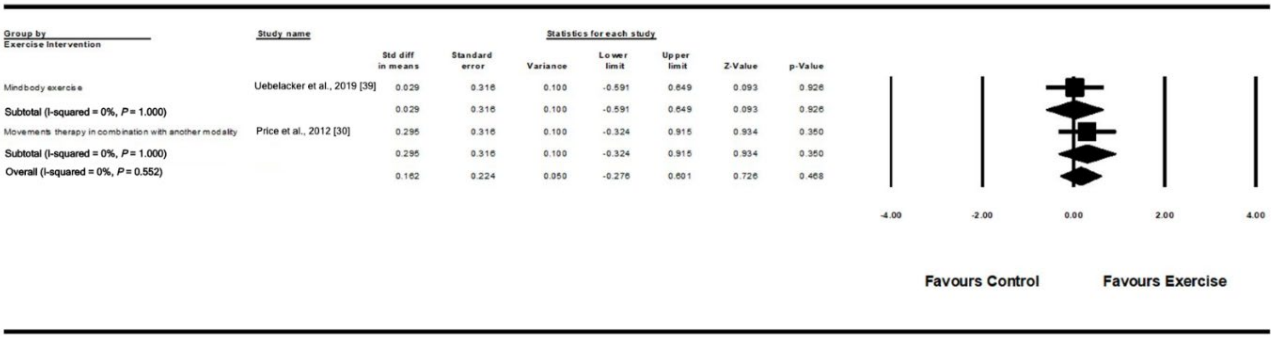


Figure 12(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on pain at post-intervention.

The effect of different types of exercise interventions on pain among female and young adults' subgroup

A subgroup analysis on the effect of physical exercise on pain at post-intervention for the two targeted drug-dependent subgroups (female and young adult subgroups) was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

3.6.5 Sleep outcome

The effect of exercise interventions on sleep quality

The included studies used various instruments to quantify sleep quality: the Insomnia Severity Index (ISI) [codes 1, 24 and 62], the Pittsburg Sleep Quality Index (PSQI) [codes 35 and 54], and the Medical Outcomes study-sleep scale (MOS-sleep) [codes 25(i) and 25(ii)]. All instruments were measured with scores.

Figure 13(a) shows the seven studies (codes 1, 24, 25(i), 25(ii), 35, 54 and 62) that examined the effects of physical exercise on sleep quality at post-intervention. The results from a random effect model showed a significant medium effect size on overall sleep quality outcomes (SMD = 0.41 [95% CI: 0.33, 0.49], P<.001, I^2 =0%).

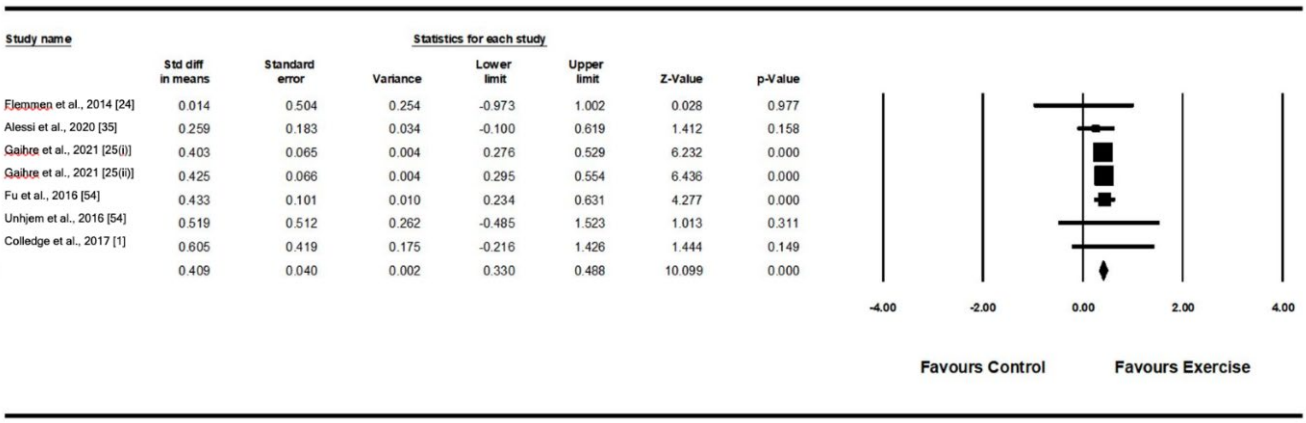


Figure 13(a). The effect of exercise interventions on sleep quality at post-intervention.

The effect of exercise interventions on sleep quality among female and young adults' subgroup

A more significant effect was observed in the female drug-dependent subgroup than in the young adult drug-dependent subgroup and the general drug-dependent population. The effect size was 0.43 (95% CI: 0.15 to 0.71) for the female drug-dependent subgroup, 0.42 (95% CI: 0.30 to 0.54) for the young adult drug-dependent subgroup, 0.32 (95% CI: -0.02 to 0.64) for the general drug-dependent population. Heterogeneity remained unchanged in the subgroups

of female and the general drug-dependent population, I^2 = 0% (P = 1.000) and I^2 = 0% (P = 0.450) respectively, whereas the young adult drug-dependent subgroup increased to I^2 = 47% (P = 0.023) (Figure 13(b)).

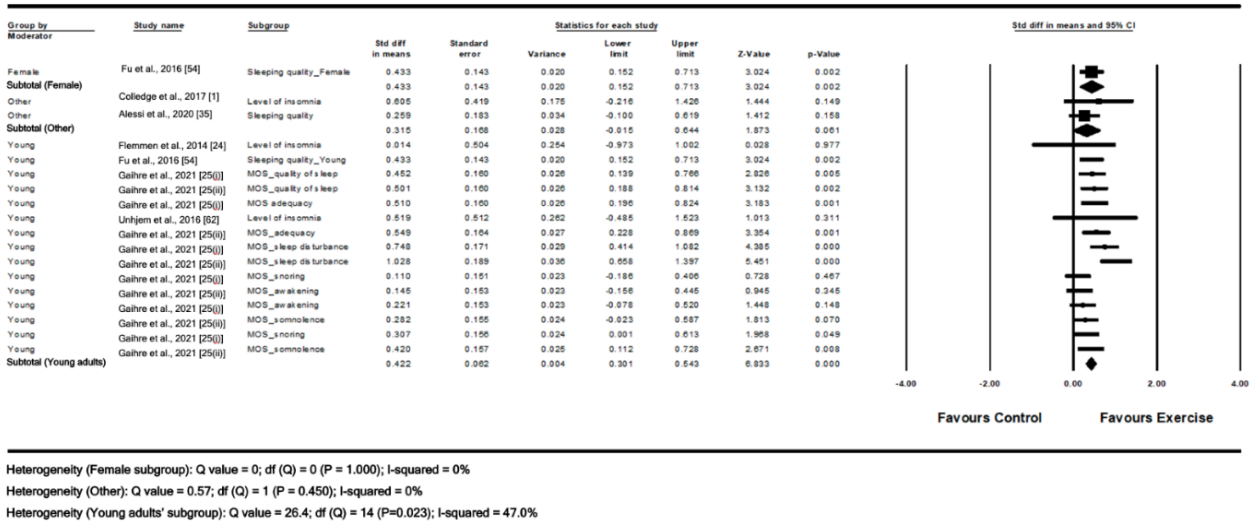


Figure 13(b). Drug-dependent subgroups analysis for the effects of exercise interventions on sleep quality at post-intervention.

The effect of different types of exercise interventions on sleep quality

Structured fitness training

A significant difference was found when comparing structured fitness training with non-exercise interventions, suggesting that structured fitness training improved sleep quality more effectively (SMD = 0.43 [95% CI: 0.30, 0.55], P < 0.05, I^2 =0%).

Mind-body exercise

A significant difference was found when comparing mind-body exercise with non-exercise interventions, suggesting that mind-body exercise was more effective in improving sleep quality (SMD = 0.41 [95% CI: 0.31, 0.52], P < 0.05, I^2 =0%).

A mixture of leisure activities and exercise

No significant difference was found when comparing a mixture of leisure activities and exercise with non-exercise interventions in improving sleep quality (SMD = 0.26 [95% CI: -0.05, 0.58], $P > 0.05$, I^2 =0%).

A mixture of sport and exercise

No significant difference was found when comparing a mixture of sport and exercise with non-exercise interventions in improving sleep quality (SMD = 0.61 [95% CI: -0.22, 1.43], $P > 0.05$, I^2 =0%).

Among the different types of exercise interventions for drug-dependent groups, a mixture of sport and exercise appeared to be most effective in improving sleep quality, followed by structured fitness training, mind-body exercise, and a mixture of leisure activities and exercise.

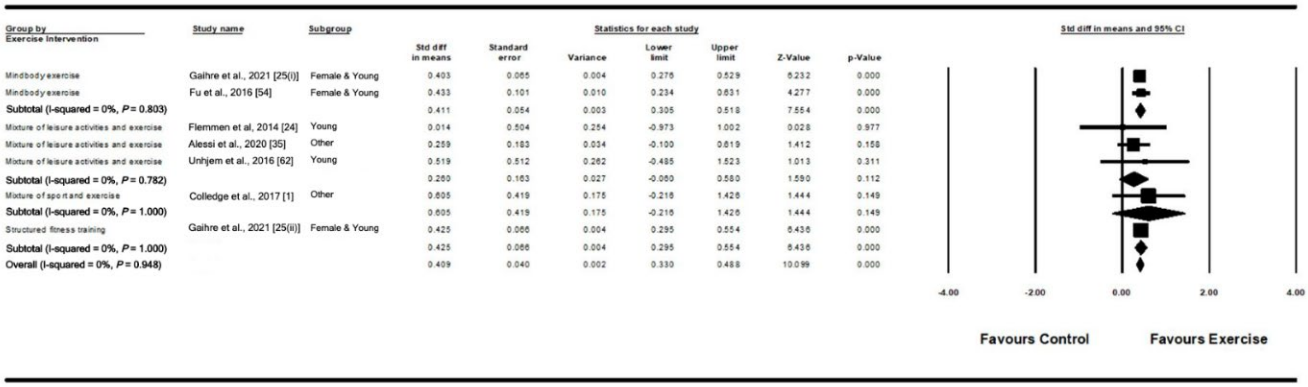


Figure 13(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on sleep quality at post-intervention.

The effect of different types of exercise interventions on sleep quality among female and young adults subgroup

Five studies (codes 24, 25(i), 25(ii), 54 and 62) that focused on the young adult drug-dependent subgroup showed a significant difference in improving sleep quality with exercise interventions compared with non-exercise interventions (SMD = 0.42 [95% CI: 0.29 to 0.54],

$P < 0.05$, I^2 =47.0%; Figure 13(d)). Subgroup analysis indicated that structured fitness training (0.45 (95% CI: 0.22 to 0.68) is superior to mind-body exercise (0.41 (95% CI: 0.26 to 0.56) and a mixture of leisure activities and exercise (0.26 (95% CI: -0.44 to 0.97) for the young adult drug-dependent subgroup in improving sleep quality.

A subgroup analysis focused on the female drug-dependent subgroup on the effect of physical exercise on sleep quality at post-intervention was unavailable because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

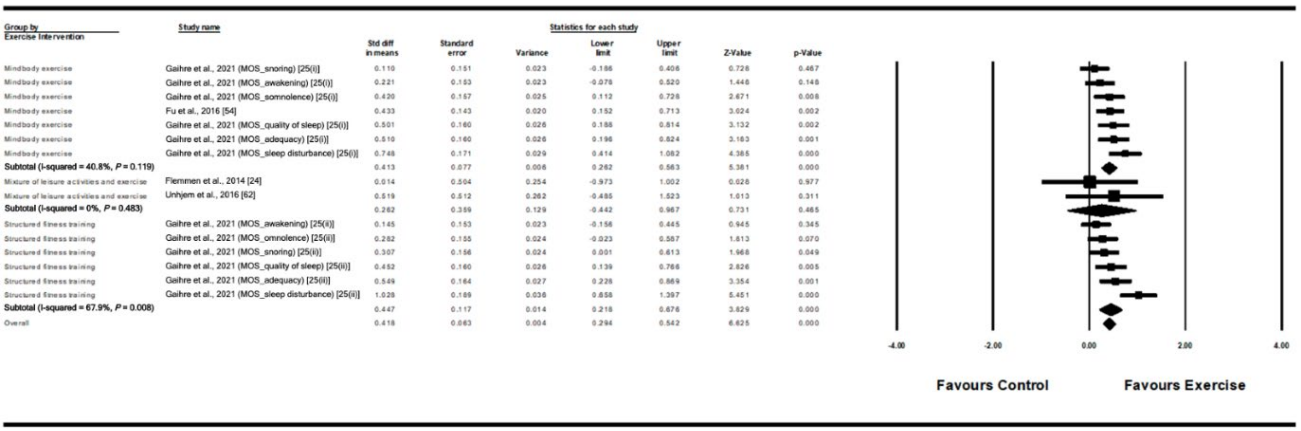


Figure 13(d). Subgroup analysis of different types of exercise interventions for young adult drug-dependent subgroup on sleep quality at post-intervention.

3.6.6 Substance use outcome

The effect of exercise interventions on substance use

The included studies used the Timeline Follow Back Questionnaire to quantify substance use. They were measured in days of use of secondary drugs, illicit heroin, illicit cocaine, and unprescribed medications [code 1], days of substance use [code 3 and 34], daily consumption of cannabis (measured in joints per day (1 joint = 0.5 grams of dry cannabis) [code 6], and days of cannabis, stimulant, and opioid consumptions [code 33].

Figure 14(a) shows five studies (codes 1, 3, 6, 33 and 34) that examined the effects of exercise interventions on substance use at post-intervention. The results from a random effect model showed a significant medium to large effect size on overall substance use outcomes (SMD = 0.62 [95% CI: 0.06, 1.17], P<0.05, I^2 =80.9%).

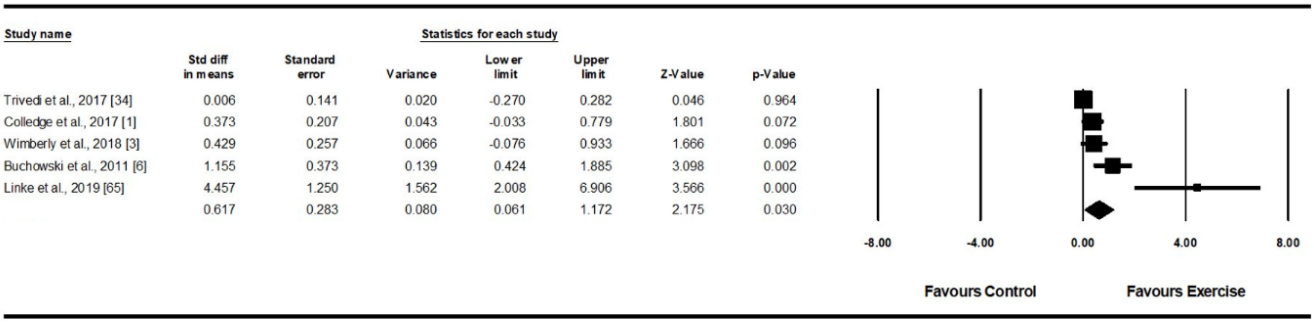


Figure 14(a). The effect of exercise interventions on substance use at post-intervention.

The effect of exercise interventions on substance use among female and young adults subgroup

A more significant effect was observed in the young adult drug-dependent subgroup than in the general drug-dependent population. The effect size was 1.16 (95% CI: 0.42 to 1.89) for the young adult drug-dependent subgroup and 0.46 (95% CI: -0.12 to 1.03) for the general drug-dependent population. Heterogeneity of the subgroups of the young adult drug-

dependent group and the general drug-dependent population decreased, with I^2=0% (P=1.000) and I^2=80.0% (P=0.002) respectively (Figure 14(b)).

A subgroup analysis focused on the female drug-dependent subgroup on the effect of physical exercise on substance use at post-intervention was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

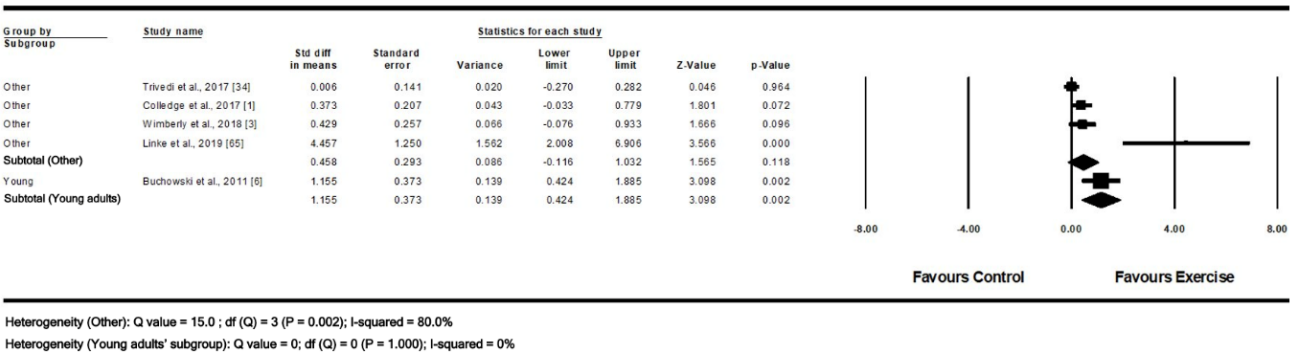


Figure 14(b). Drug-dependent subgroups analysis for the effects of exercise interventions on substance use at post-intervention.

The effect of different types of exercise interventions on substance use

Aerobic exercise

A significant difference was found when comparing aerobic exercise with non-exercise interventions in terms of substance use, suggesting that aerobic exercise was more effective in reducing substance use (SMD = 1.16 [95% CI: 0.42, 1.89], $P < 0.05$, I^2 =0%).

Mind-body exercise

No significant difference was found when comparing mind-body exercise with non-exercise interventions in reducing substance use (SMD = 0.43 [95% CI: -0.08, 0.93], $P > 0.05$, I^2 =0%).

Structured fitness training

A significant difference was found when comparing structured fitness training with non-exercise interventions, suggesting that structured fitness training was more effective in reducing substance use (SMD = 4.46 [95% CI: 2.01, 6.91], $P < 0.05$, I^2 =0%).

Mixture of sports and exercise

No significant difference was found when comparing a mixture of sports and exercise with non-exercise interventions in reducing substance use (SMD = 0.37 [95% CI: -0.03, 0.78], $P > 0.05$, I^2 =0%).

Individualized physical activity interventions tailored by interventionist

No significant difference was found when comparing individualized physical activity interventions tailored by interventionists with non-exercise interventions in reducing substance use (SMD = 0.01 [95% CI: -0.27, 0.28], $P > 0.05$, I^2 =0%).

Among the different types of exercise interventions for drug-dependent groups, structured fitness training appeared to be most effective in reducing substance use, followed by aerobic exercise, mind-body exercise, a mixture of sports and exercise, and individualized physical activity interventions tailored by interventionists.

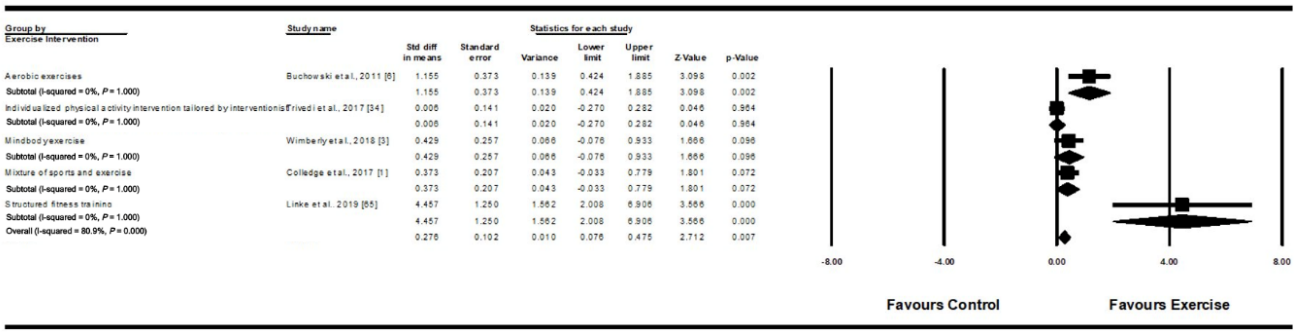


Figure 14(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on substance use at post-intervention.

The effect of different types of exercise interventions on substance use among female and young adults' group

A subgroup analysis on the effect of physical exercise on substance use at post-intervention for the two targeted drug-dependent subgroups (female and young adult subgroups) was not available because there were insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).

The effect of exercise interventions on craving

Figure 15(a) shows nineteen studies (codes 5, 6, 14, 15(i), 15(ii), 33, 36(i), 36(ii), 49(i), 49(ii), 53(i), 53(ii), 53(iii), 60(i), 60(ii), 60(iii), 63(i), 63(ii) and 80) that examined the effects of physical exercise on craving at post-intervention. The results from a random effect model showed a significantly large effect size on overall craving outcomes (SMD = 1.60 [95% CI: 1.01, 2.19], P<0.01, I^2 =93.0%).

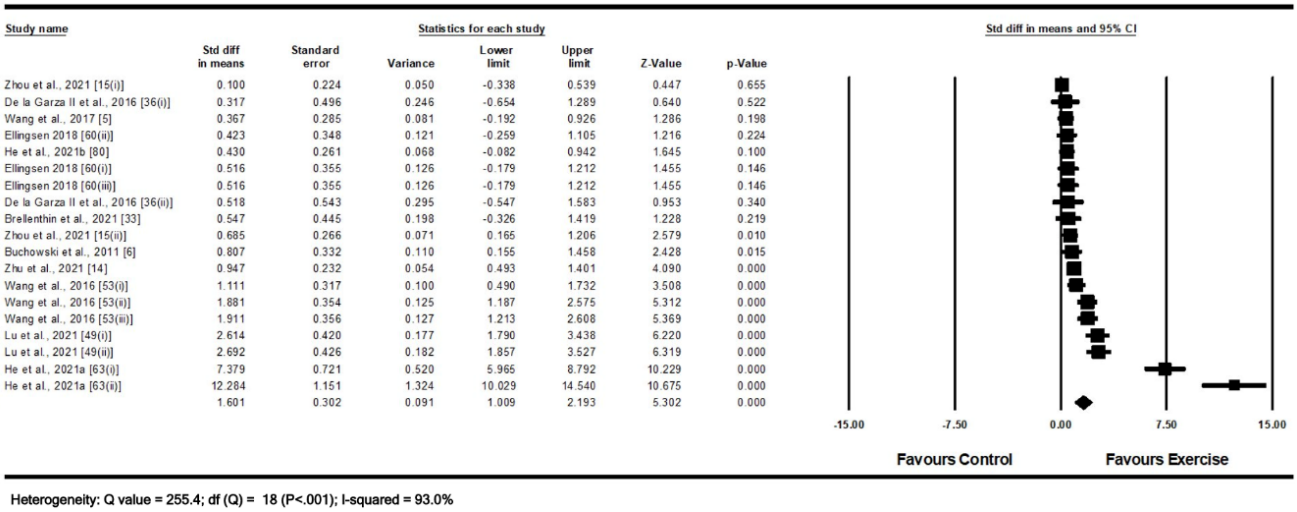
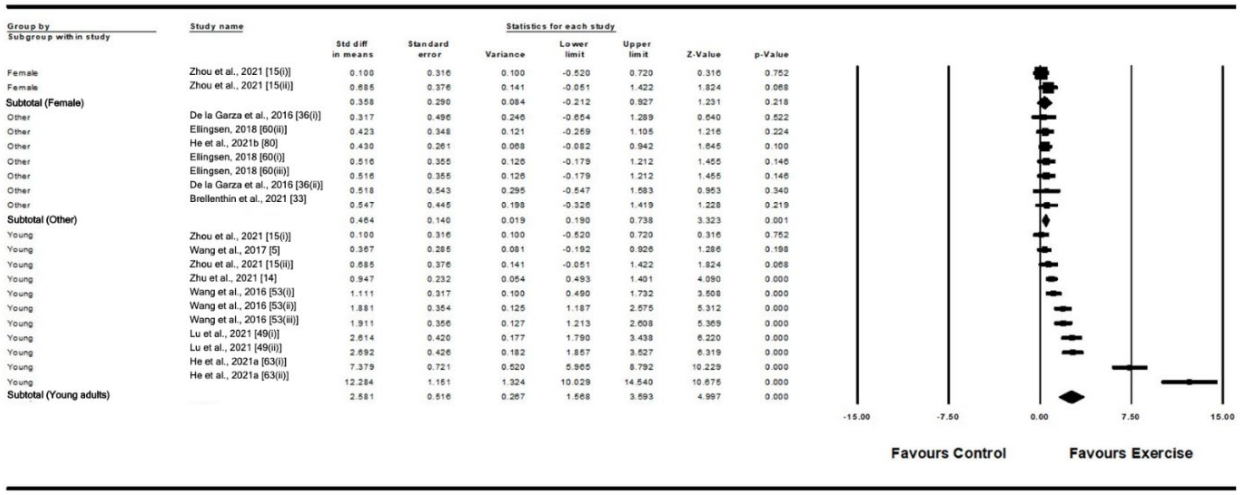


Figure 15(a). The effect of exercise interventions on craving at post-intervention.

The effect of exercise interventions on craving among female and young adults' subgroup

A more significant effect was observed in the young adult drug-dependent subgroup than in the general drug-dependent population and the female drug-dependent subgroup. The effect size was 2.58 (95% CI: 1.57 to 3.59) for the young adult drug-dependent subgroup, 0.46 (95% CI: 0.19 to 0.74) for the general drug-dependent population and 0.36 (95% CI: -0.21 to 0.93) for the female drug-dependent subgroup. Heterogeneity varied between subgroups. Young adult drug-dependent subgroup increased to I^2 = 95.0% (P <.001), whereas the general drug-dependent population and the female drug-dependent subgroup decreased to I^2 = 0% (P=1.000) and I^2 = 29.5% (P=0.234), respectively (Figure 15(b)).



Heterogeneity (Female subgroup): Q value = 1.42; df (Q) = 1 (P = 0.234); I-squared = 29.5%

Heterogeneity (Other): Q value = 0.21; df (Q) = 6 (P = 1.000); I-squared = 0%

Heterogeneity (Young adults' subgroup): Q value = 217.88; df (Q) = 10 (P<.001); I-squared = 95.4%

Figure 15(b). Drug-dependent subgroups analysis for the effects of exercise interventions on craving at post-intervention.

The effect of different types of exercise interventions on craving

Aerobic exercise

A significant difference was found when comparing aerobic exercise with non-exercise interventions, suggesting that aerobic exercise was more effective in reducing craving (SMD = 0.94 [95% CI: 0.56, 1.33], $P < 0.05$, I^2 =77.9%).

Structured fitness training

A significant difference was found when comparing structured fitness training with non-exercise interventions, suggesting that structured fitness training was more effective in reducing craving (SMD = 5.54 [95% CI: 1.72, 9.35], $P < 0.05$, I^2 =98.0%).

Mind-body exercise

No significant difference was found when comparing mind-body exercise with non-exercise interventions in reducing craving (SMD = 0.43 [95% CI: -0.08, 0.94], $P > 0.05$, I^2 =0%).

Sports

No significant difference was found when comparing sports with non-exercise interventions in reducing craving (SMD = 0.52 [95% CI: -0.18, 1.21], $P > 0.05$, I^2 =0%).

Among the different types of exercise interventions for drug-dependent groups, structured fitness training appeared to be most effective in reducing craving, followed by aerobic exercise, sports, and mind-body exercise.

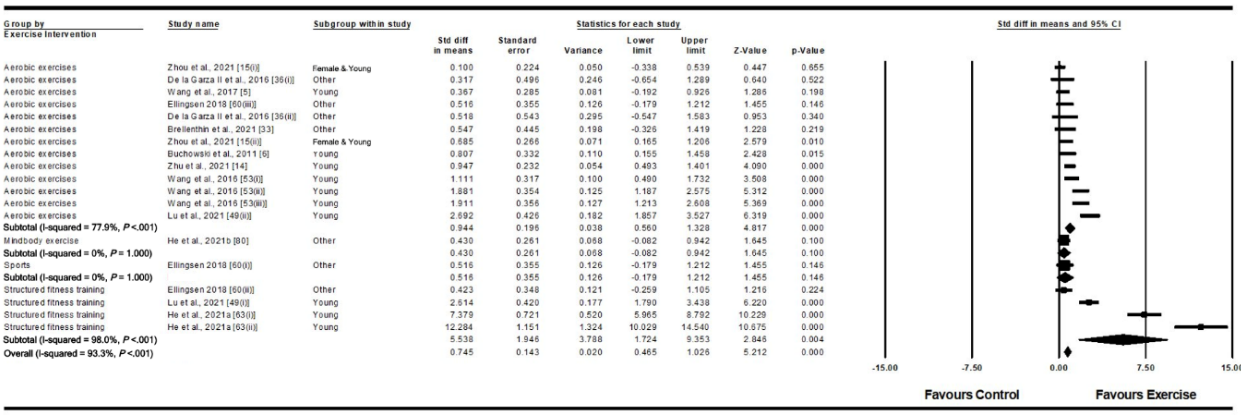


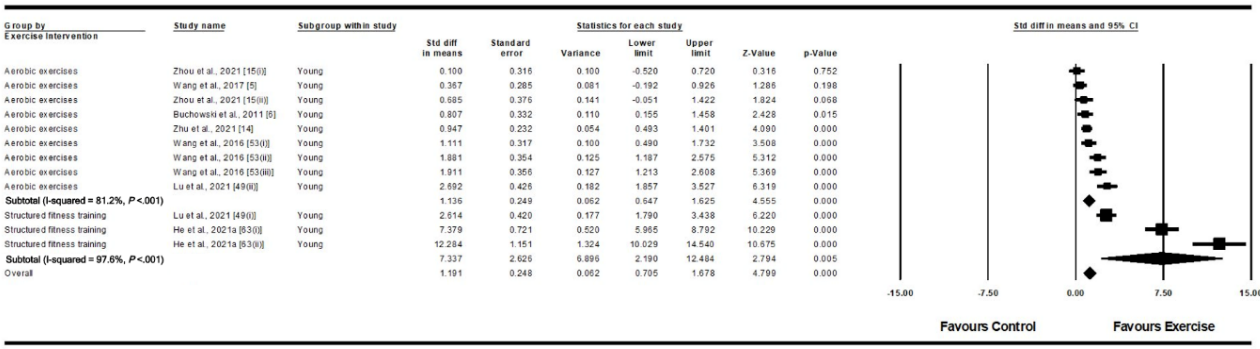
Figure 15(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on craving at post-intervention.

The effect of different types of exercise interventions on craving among female and young adults' subgroup

Twelve studies (codes 5, 6, 14, 15(i), 15(ii), 49(i), 49(ii), 53(i), 53(ii), 53(iii), 63(i) and 63(ii)) that focused on the young adult drug-dependent subgroup showed a significant difference in reducing craving with exercise interventions compared with non-exercise interventions (SMD = 1.19 [95% CI: 0.71, 1.68], P<0.05, I^2 =95.0%; Figure 15(d)). Subgroup analysis indicated that structured fitness training (7.34 (95% CI: 2.19 to 12.48) is superior to aerobic exercise (1.14 (95% CI: 0.65 to 1.63) for the young adult drug-dependent subgroup in reducing craving.

A subgroup analysis focused on the female drug-dependent subgroup on the effect of physical exercise on craving at post-intervention was not available because there were

insufficient studies on this aspect to provide a more precise estimate of the true effect (Borenstein et al., 2021).



Group by Exercise Intervention	Study name	Subgroup within study	Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Aerobic exercises	Zhou et al., 2021 [15(i)]	Young	0.100	0.316	0.100	-0.520	0.720	0.316	0.752
Aerobic exercises	Wang et al., 2017 [5]	Young	0.367	0.285	0.081	-0.192	0.926	1.286	0.198
Aerobic exercises	Zhou et al., 2021 [15(ii)]	Young	0.685	0.376	0.141	-0.051	1.422	1.824	0.068
Aerobic exercises	Buchowski et al., 2011 [6]	Young	0.807	0.332	0.110	0.155	1.458	2.428	0.015
Aerobic exercises	Zhu et al., 2021 [14]	Young	0.947	0.232	0.054	0.493	1.401	4.090	0.000
Aerobic exercises	Wang et al., 2016 [53(i)]	Young	1.111	0.317	0.100	0.490	1.732	3.508	0.000
Aerobic exercises	Wang et al., 2016 [53(ii)]	Young	1.881	0.354	0.125	1.187	2.575	5.312	0.000
Aerobic exercises	Wang et al., 2016 [53(iii)]	Young	1.911	0.356	0.127	1.213	2.608	5.369	0.000
Aerobic exercises	Lu et al., 2021 [49(ii)]	Young	2.592	0.426	0.182	1.857	3.527	6.319	0.000
Subtotal (I-squared = 81.2%, *P* <.001)			1.136	0.249	0.062	0.647	1.625	4.555	0.000
Structured fitness training	Lu et al., 2021 [49(i)]	Young	2.614	0.420	0.177	1.790	3.438	6.220	0.000
Structured fitness training	He et al., 2021a [63(i)]	Young	7.379	0.721	0.520	5.965	8.792	10.229	0.000
Structured fitness training	He et al., 2021a [63(ii)]	Young	12.284	1.151	1.324	10.029	14.540	10.675	0.000
Subtotal (I-squared = 97.6%, *P* <.001)			7.337	2.626	6.896	2.190	12.484	2.794	0.005
Overall			1.191	0.248	0.062	0.705	1.678	4.799	0.000

Figure 15(d). Subgroup analysis of different types of exercise interventions for young adult drug-dependent subgroup on craving at post-intervention.

3.6.7 Quality of life outcomes

The effect of exercise interventions on Quality of life

The included studies used two measurements to quantify Quality of life: the 36-item short-form health survey questionnaire (SF-36) (measured in the eight domains of vitality, bodily pain, general health perceptions, mental health, physical functioning, physical role functioning, emotional role functioning, and social role functioning) [code 1, 51, 70] and the Quality of life for drug addicts (QOL-DA) [codes 7, 47, 48, 56(i), 56(ii), 57, 63(i) and 63(ii)]. Both instruments were measured with scores.

Figure 16(a) shows eleven studies (codes 1, 7, 47, 48, 51, 56(i), 56(ii), 57, 63(i), 63(ii) and 70) that examined the effects of physical exercise on Quality of life at post-intervention. The results from a random effect model showed a significant medium to large effect size on overall Quality of life outcomes (SMD = 0.59 [95% CI: 0.34, 0.84], P<0.001, I^2 =89.8%)

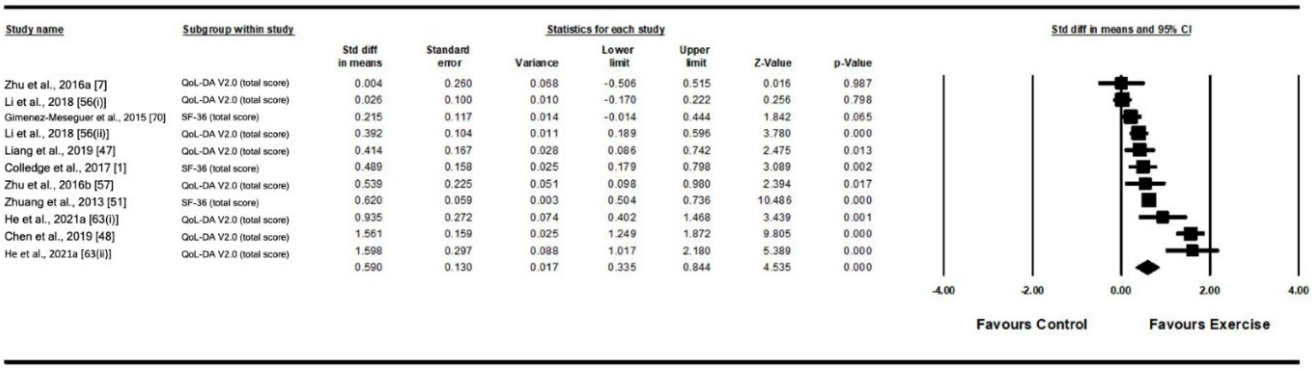
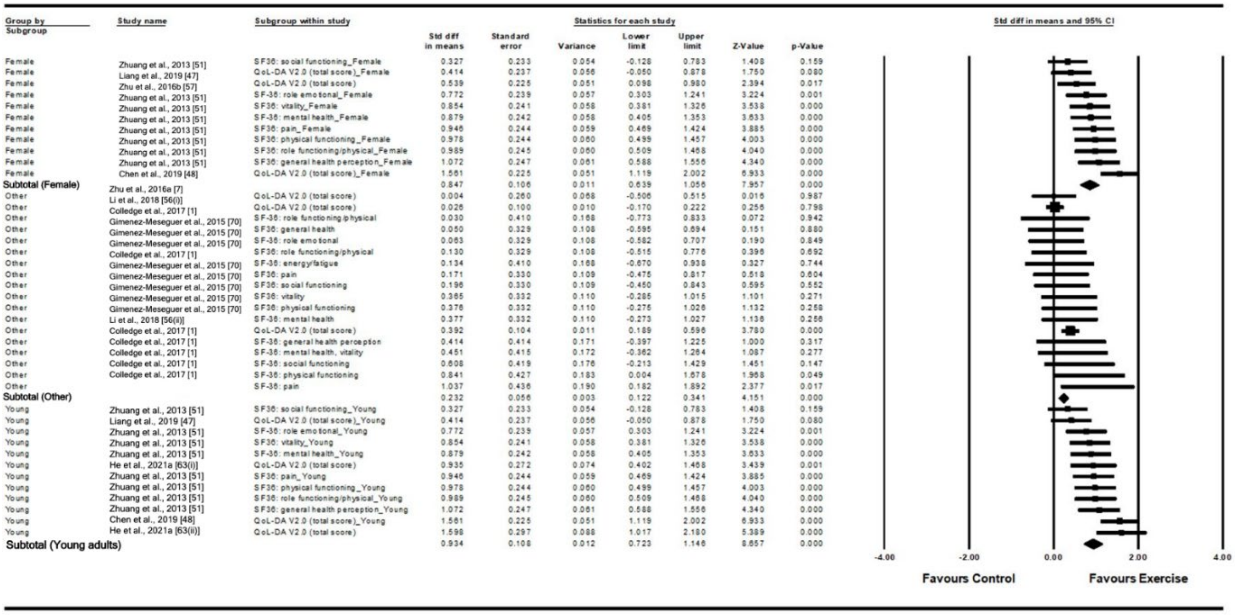


Figure 16(a). The effect of exercise interventions on Quality of life at post-intervention.

The effect of exercise interventions on Quality of life among female and young adults' group

A more significant effect was observed in the young adult drug-dependent subgroup than in the female drug-dependent subgroup and the general drug-dependent population. The effect

size was 0.93 (95% CI: 0.72 to 1.15) for the young adult drug-dependent subgroup, 0.85 (95% CI: 0.64 to 1.06) for female drug-dependent subgroup, and 0.23 (95% CI: 0.12 to 0.34) for the general drug-dependent population. Heterogeneity of the subgroups of young adult drug-dependent group, female drug-dependent subgroup and the general drug-dependent population decreased, with I^2=56.7% (P=0.008), I^2=54.6% (P=0.015), and I^2=0% (P=0.547) respectively (Figure 16(b)).



Heterogeneity (female subgroup): Q value = 22.0; df (Q) = 10 (P = 0.015); I-squared = 54.6%
Heterogeneity (Other): Q value = 15.68; df (Q) = 17 (P = 0.547); I-squared = 0%
Heterogeneity (Young adults' subgroup): Q value = 25.41; df (Q) = 11 (P = 0.008); I-squared = 56.7%

Figure 16(b). Drug-dependent subgroups analysis for the effects of exercise interventions on quality of life at post-intervention.

The effect of different types of exercise interventions on quality of life

Structured fitness training

No significant difference was found when comparing structured fitness training with non-exercise interventions in improving quality of life (SMD = 0.83 [95% CI: -0.17, 1.81], P > 0.05, I^2 =93.8%).

Mind-body exercise

A significant difference was found when comparing mind-body exercise with non-exercise interventions, suggesting that mind-body exercise was more effective in improving quality of life (SMD = 0.47 [95% CI: 0.24, 0.70], $P < 0.05$, I^2 =52.5%).

Mixture of leisure activities and exercise

No significant difference was found when comparing a mixture of leisure activities and exercise with non-exercise interventions in improving quality of life (SMD = 0.22 [95% CI: -0.01, 0.44], $P > 0.05$, I^2 =0%).

Mixture of sports and exercise

A significant difference was found when comparing a mixture of sports and exercise with non-exercise interventions, suggesting that a mixture of sports and exercise was more effective in improving quality of life (SMD = 0.49 [95% CI: 0.18, 0.80], $P < 0.05$, I^2 =0%).

Movement therapy in combination with another modality

A significant difference was found when comparing movement therapy in combination with another modality with non-exercise interventions, suggesting that movement therapy in combination with another modality was more effective in improving quality of life (SMD = 0.97 [95% CI: -0.18, 2.12], $P < 0.05$, I^2 =97.4%).

Among the different types of exercise interventions for drug-dependent groups, movement therapy in combination with another modality appeared to be most effective in improving quality of life, followed by structured fitness training, a mixture of sports and exercise, mind-body exercise, and a mixture of leisure activities and exercise.

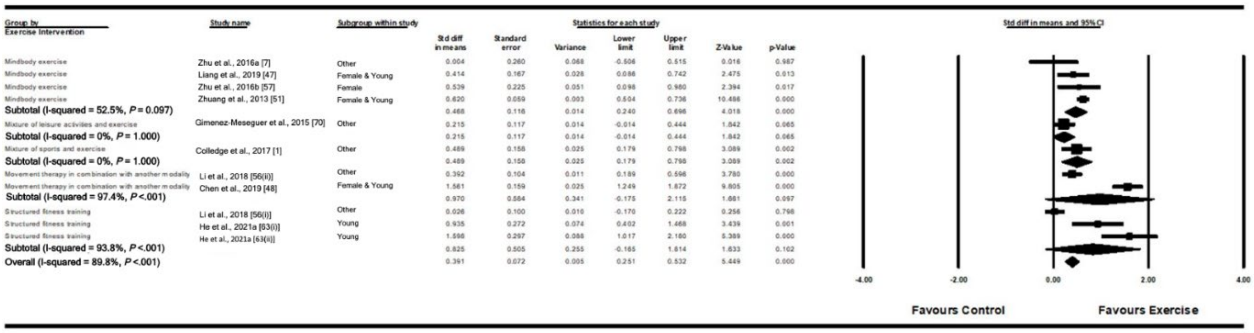


Figure 16(c). Subgroup analysis of different types of exercise interventions for drug-dependent groups on quality of life at post-intervention.

The effect of different types of exercise interventions on quality of life among female subgroup

Four studies (codes 47, 48, 51 and 57) that focused on the female drug-dependent subgroup showed a significant difference in increasing quality of life with exercise interventions compared with non-exercise interventions (SMD=0.69 [95% CI: 0.55, 0.82], P < 0.05, I^2 =82.8%; Figure 16(d)). Subgroup analysis indicated that movement therapy in combination with another modality (1.56 (95% CI: 1.12 to 2.00)) is superior to mind-body exercise (0.59 (95% CI: 0.44 to 0.74)) for the female drug-dependent subgroup in improving quality of life.

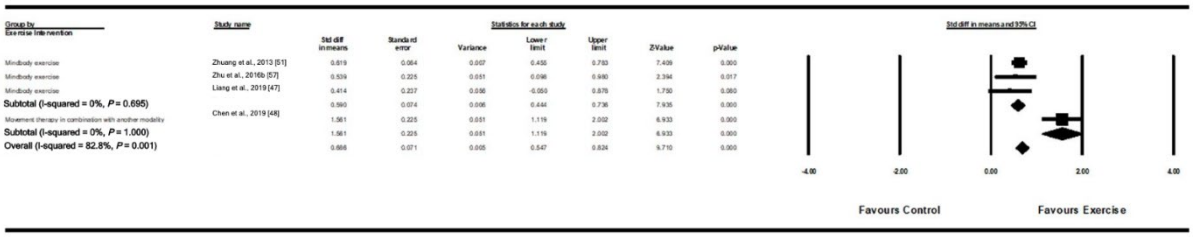


Figure 16(d). Subgroup analysis of different types of exercise interventions for female drug-dependent subgroup on quality of life at post-intervention.

The effect of different types of exercise interventions on quality of life among young adults' sub-group

Five studies (code 47, 48, 51, 63(i), 63 (ii)) that focused on the young adult drug-dependent subgroup showed a significant difference in increasing quality of life with exercise interventions compared with non-exercise interventions (SMD=0.73 [95% CI: 0.59 to 0.87], *P*<0.05, I^2 =84.6%; Figure 16(e)). Subgroup analysis indicated that movement therapy in

combination with another modality (1.56 (95% CI: 1.12 to 2.00)) is superior to structured fitness training (1.26 (95% CI: 0.61 to 1.91), followed by mind-body exercise (0.60 (95% CI: 0.44 to 0.75) for the young adult drug-dependent subgroup in improving quality of life.

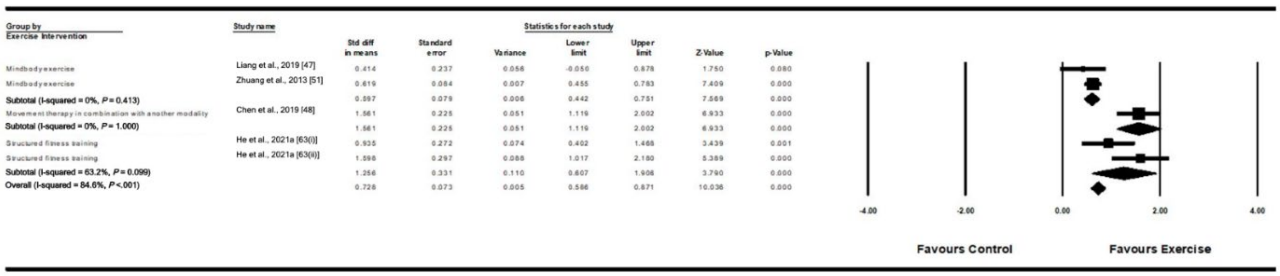


Figure 16(e). Subgroup analysis of different types of exercise interventions for young adult drug-dependent subgroup on quality of life at post-intervention.

3.7 Objective 4: To synthesize recurring themes related to the subjective experiences of physical exercise intervention among drug-dependent group(s)

The meta-aggregation of qualitative data converges and complements quantitative outcomes identified in the previous chapter and reveals unique benefits of exercise intervention designed for the drug-dependent population that cannot be found in quantitative findings.

The complementary qualitative findings on quantitative outcomes can be found in Table 10.1. The meta-aggregation of qualitative data complements and gives additional understanding on the following outcomes: body composition, flexibility and strength, functional ability, general health, physical activity level, behavioural regulation, pain, anxiety, depression, emotional expression, stress, food-related sensation and selection, changes in mood state, attitudes towards the body, self-evaluation, mindfulness domain, sleep quality, substance-use, craving, withdrawal symptoms, quality of life, and perceived social support.

Table 10.1

Quantitative outcomes	Qualitative data	
	Second-level construct	First-level construct
Physical and Physiological		
Body composition		"When I started to exercise when I got here, I was 138 kg, and thanks to exercise, I've lost 11 kg in not much time (Participant 1)." (code: 70, mixture of leisure activities and exercise, early middle-aged, N/S, N/S)

		"The best benefit of the program has been achieving a weight loss of 10–11 kg (Participant 6)." (code: 70, mixture of leisure activities and exercise, early middle-aged, N/S, N/S)
Flexibility and strength	Greater flexibility and physical strength (code:22, mind-body exercise, young, inpatient, voluntary treatment)	"The best benefit has been finding myself more elastic and more flexible. My body feels lighter and more flexible (Participant 1). For example, I used to come here to play soccer, and I could only do three or four runs, and that was it. Now I have been exercising and gaining more endurance and strength (Participant 6)." (code: 70, mixture of leisure activities and exercise, early middle-aged, N/S, N/S)
Functional ability	PT 101 identified progress towards an increased ability to move and control their bodies as a benefit to the class (code: 76, mind-body exercise, N/S, inpatient & outpatient, other)	".... And my body was beginning to acquire mobility. I had to do something with it. So, I went cycling" Jordy. (code: 78, mixture of sport and exercise, young, inpatient, N/S)
General health	By the end of the program, subjects achieved greater flexibility and physical strength, their energy level increased, they became brighter and more open in appearance and had a clearer complexion, they appeared more focused and alert, they were more verbal and made better eye contact and were more able to ask for appropriate help (as distinct from medication seeking behaviour), they expressed fewer complaints about pain, sleep or physical discomfort and exhibited less emotional reactivity.	"... I see that my muscles begin to show, my body is a little firmer, and I'm glad. I feel beautiful in and out, and I think this will show to other people too…" (code: 78, mixture of sport and exercise, young, inpatient, N/S) "At first, I felt very clumsy with the moves, but I noticed that from each time that I participated, it was ...easier to go from one pose into another, and it definitely felt more fluid, I guess you can say. And that felt good, it feels good to be like, "Okay," you know, "I feel like I'm doing this right." I feel like it gives me something to concentrate on in a good way, and not

	(code:22, mind-body exercise, young, inpatient, voluntary treatment) The benefits and advantages identified by participants were primarily physical, including: improved fitness and other physiological benefits; the adoption of healthy behaviours beyond the exercise groups, such as reduced smoking and replacing elevator use with stairs; new exercise knowledge; and more energy. (code: 72, mixture of sport and exercise, early middle-aged, inpatient, voluntary treatment) Participants said that they felt fitter/healthier (code: 73, structured fitness training, early middle-aged, outpatient, other)	something I can't do anything about. I feel like it's something that I can work on, and I can progress and become better at, and that feels good because not everything that we do is that easy, or for me to kind of come together and feel like I'm doing something productive for my body, I guess I can say, 'cause after so many years of abusing my body and not taking care of it properly, it feels good to be able to do good for it, you know?" (code: 76, mind-body exercise, N/S, inpatient & outpatient, other)
Behavioural		
Physical activity	All reported walking regularly as part of their daily transportation pattern (code: 76, mind-body exercise, N/S, inpatient & outpatient, other)	"I always tried to keep some form of exercise, even if it is just walking, just to keep myself going, 'cause I believe it's important" (PT 101) (code: 76, mind-body exercise, N/S, inpatient & outpatient, other)
Behavioural regulation		"I feel more in control now. The chaos reduced a bit." (code: 75, structured fitness training, early middle-aged, outpatient, other)
Clinical/Health		

Pain	A better sense of the body is expressed both as increased awareness of physical markers such as pulse or breathing but also as increased sensitivity to pain (code: 75, structured fitness training, early middle-aged, outpatient, other)	
Psychological		
Anxiety and Depression	Attributed their feeling better as a result of the yoga (code:22, mind-body exercise, young, inpatient, voluntary treatment) Psychological benefits included improved mood and motivation to both exercise and fulfil daily tasks. (code: 72, mixture of sport and exercise, early middle-aged, inpatient, voluntary treatment)	I feel better about myself. I feel more confident in myself instead of being depressed or indifferent" (Mike). (code: 78, mixture of sport and exercise, young, inpatient, N/S)
Emotion and expression	Exercise seemed to positively influence the way participants handled the chaotic emotional states (code: 78, a mixture of sport and exercise, young, inpatient, N/S)	"Me, for one, exercise helped me vent my anger, especially at the beginning. Yes, it calms me down. Because I too have selfishness issues and such. So, it often helps me when I can't deal with my anger. It helps to go and work out and "leave" my anger there" (Marios). (code: 78, mixture of sport and exercise, young, inpatient, N/S) "I am more patient and tolerant. I would have a short fuse, but I am finding I am more calm. I am not in such a rush anymore. With the kids, I am listening a lot more; with my oldest, I am a lot more patient. (Nicole)."

	(code:71, structured fitness training, young, outpatient, voluntary treatment) "Exercise helps me decompress from stress, anger, tension, sadness, all kinds of emotions. If I am in a state, I'll just run, cry, joke around, and it will get better. I'm not saying there are no other ways to vent myself, but if it is an immediate relief you're looking for that's physical, isn't it?" (Asterix). (code: 78, mixture of sport and exercise, young, inpatient, N/S)
Stress	"What I like the most about the group is that I learned how to work with my inner stress [and] also my attitude in life. Just for today, I can sit, feel, deal in a positive way." (code:23, mind-body exercise, young, inpatient & outpatient, voluntary treatment) "Day 1--At first, I didn't want to do it, but I'm glad I did. It helped me to forget about some problems and relieve some stress." (code: 40, movements therapy in combination with another modality, young, outpatient, other) "Very motivating. It got my anger and stress level down." (code: 40, movements therapy in combination with another modality, young, outpatient, other) "I loved playing tile drums. What stress I did have is gone. Was stress

		relieving." (code: 40, movements therapy in combination with another modality, young, outpatient, other) "We always ended up happy after the exercise session, at least me. Exercise allows us to forget about daily stress, it seems to reduce the load on our shoulders, it gives us a breathing space...(Participant 9)" (code: 70, mixture of leisure activities and exercise, early middle-aged, N/S, N/S) "Now we know that there are other alternatives to drugs that can be used to deal with stress." (code: 74, aerobic exercises, early middle-aged, inpatient, voluntary treatment)
Food-related sensation and selection	Participants said that they had started healthier eating (code: 73, structured fitness training, early middle-aged, outpatient, other) As a result of the improved body image and body sensation, healthier eating habits were adopted. (code: 78, mixture of sport and exercise, young, inpatient, N/S) As smoking and eating habits were changing there was also a general tendency to better self-care as a result of engaging in exercise sessions. (code: 78, mixture of sport and exercise, young, inpatient, N/S)	"As soon as I started to exercise, I could quit eating bread just for the hell of it or not have dessert in more, and I also started minding what I ate." (Mike). (code: 78, mixture of sport and exercise, young, inpatient, N/S) "...the way I felt the things around me changed, my sense of smell, taste, the colours. Like waking up from a dream... (code: 78, a mixture of sport and exercise, young, inpatient, N/S)

Changes in mood state	Improved mood caused higher energy levels, which in turn brought a vitality that made the participants creative throughout the day. (code: 78, mixture of sport and exercise, young, inpatient, N/S)	"...it generally helps me to do everything better, to sleep better, it animates me to do things. Let's say that I'm in a better mood cause of the workout. I will sit down and start writing music. Then I'll try to find things to do, to read books" (Paco). (code: 78, mixture of sport and exercise, young, inpatient, N/S) "It was fun and put me in a good mood for the day." (code: 40, movements therapy in combination with another modality, young, outpatient, other) "Exercise positively affects me so that I'm in a better mood regarding treatment. It helps me be more receptive to what they will give to me. To feel stronger so I can accept something I will probably not like. Exercise helps me deal with it" (Paco). (code: 78, mixture of sport and exercise, young, inpatient, N/S)
Attitudes towards the body		"My body feels good not only in general but also after a workout; it feels alive and healthy (Pause). It's a beautiful feeling as for many years, both when I used drugs and when I did not, I neglected my body. And now that I feel it recovering, I do not know, I'm pleased. I'm glad to see I've still got it. I haven't lost the war, though it may be late, it's not too late. I find that kind of reassuring" (Hristos). (code: 78, mixture of sport and exercise, young, inpatient, N/S)

		"Oh, I can feel my body is stronger (Pause). I feel like it is slowly changing. I feel very well, wonderful. I like it. Because I'm doing something good for me and my body. Before, I was killing it, whereas now I'm building it up. I'm making it stronger, sounder, more like it should be" (Paco). (code: 78, mixture of sport and exercise, young, inpatient, N/S "I saw a big difference in my body. And I loved it. It helps me. When I do not feel well, I am bored, and I do not have what to do, I go (pause) and just like that within the first 5 minutes. As soon as you go, you like what you do, you are happy. I'm happy when I see the changes in my body" (Mike). (code: 78, mixture of sport and exercise, young, inpatient, N/S)
Self-evaluation	The enhancement of self-esteem was reported by a number of inmates who participated in this program (code: 74, aerobic exercises, early middle-aged, inpatient, voluntary treatment) Participants also speak of a new self-confidence since sport has provided an experience of being able to do more than they were aware they could. (code: 75, structured fitness training, early middle-aged, outpatient, other)	"Exercise has made me excel at a cognitive and mental level. What Jorge (the instructor) has encouraged us to do has been to feel a little bit better about ourselves every day (Participant 4)." (code: 70, mixture of leisure activities and exercise, early middle-aged, N/S, N/S)
Mindfulness domain	Appeared more focused and alert (code:22, mind-body exercise, young, inpatient, voluntary treatment)	"Learning to notice being in the present moment was beautiful for me." (code:23, mind-body exercise,

		young, inpatient & outpatient, voluntary treatment)
	As PT 109 described, the class was a space where she could manage her worries by staying in the present moment (code: 76, mind-body exercise, N/S, inpatient & outpatient, other)	"Learning to be mindful and live in the present," "learning to acknowledge my feelings," "taking control of my sensation and pay attention to my breath" and "getting in touch with the feelings and how to deal with them and move on." (code:23, mind-body exercise, young, inpatient & outpatient, voluntary treatment)
Sleep quality	A number slept better at night and had stopped taking sleeping pills. (code: 75, structured fitness training, early middle-aged, outpatient, other)	"I've been sleeping better since I started yoga. My mind doesn't race, I don't wake up racing" (PT 102) (code: 76, mind-body exercise, N/S, inpatient & outpatient, other)
	Participants associated the relaxation of yoga with improved sleep (code: 76, mind-body exercise, N/S, inpatient & outpatient, other)	
Substance-use		
Substance use	Of these 20 participants one year after finishing the treatment, five described themselves as free of substance abuse, 10 as having reduced their intake, and four as not having experienced any change in their substance abuse. (code: 75, structured fitness training, early middle-aged, outpatient, other)	"If there were no gym or training, I would have nothing else to do, only to drink and take drugs. The gym and sports are definitely a big thing like, 'cause it passes hours during the day. (Participant 8, aged 21 years)" (code: 68, mixture of leisure activities and exercise, young, outpatient, voluntary treatment)
		"Exercise helps me feel better about myself. It has given me goals that I can work towards, so that I will be less likely to use drugs." (code: 74, aerobic exercises, early middle-aged, inpatient, voluntary treatment)

	"If I wasn't doing that, I know I'd be still on the drugs. That's one day a week that football. One day a week ... it's good 'cos while I'm doing that ... I mean, what's the point of stayin' clean if you've got nowt to do? I would just end up back on the drugs." (code: 77, sports, young, outpatient, voluntary treatment)
	"It's the only time I'm out when I'm through there [Second Chance]. I never go out with the lads or anything like that. Like all my mates, they're still on drugs ... I'm just doing the same, trying to keep myself clean, gettin' fitter and all that ... Not going to get much fitter, but it's something, it's better than now, but it's all I've got." (code: 77, sports, young, outpatient, voluntary treatment)
Craving	"The sport had a big part in keeping my head straight and keeping me off the drink, the drugs and stuff. The sport is kind of a substitute for the drink and the drugs. I swapped them around just to keep me occupied and busy. Ah, I need it. I need it to fill the gap in the other stuff that I was doing. I mean, cause if I wasn't doing sports, I would be back drinking, and I would be back f**king taking drugs and stuff, so it is important to me. (Participant 2, aged 24 years)" (code: 68, mixture of leisure activities and exercise, young, outpatient, voluntary treatment)
	"I have got a big void to fill in without filling it with drink and drugs. There are times I will just go off for a run for an hour, and it would totally take me

		away from the mind frame I'm in. It is not just a gap now, and it's routine in my life. It is the balance in my life, like you know. I have an addictive mind, and I get obsessed with what makes me feel good. That is my kind of release. It helps me get through my day and stuff like that. (Participant 7, aged 25 years)" (code: 68, mixture of leisure activities and exercise, young, outpatient, voluntary treatment) "The desire to use drugs has reduced because doing exercise and using drugs are just totally incompatible. In fact, I am a very anxious person because I have that kind of genes, nervous and unsettled, but this (exercise program) is perfect for me. It relaxes me. What I have is an impulsiveness and nervousness that drives me to a state of anger, of rage, and then I want to run away and consume (Participant 4)." (code: 70, mixture of leisure activities and exercise, early middle-aged, N/S, N/S)
Withdrawal symptoms	Improved fitness reduced suffering during withdrawal (code: 75, structured fitness training, early middle-aged, outpatient, other)	"I had no strength. I would go from one sofa to the other. I had zero energy, and smoked like a chimney. As expected, I didn't like the way I looked. I was like, 'Just look at yourself!' As if my gloomy mental state didn't make me feel bad enough already, the way my body looked was one more blow" (Hristos) (code: 78, mixture of sport and exercise, young, inpatient, N/S) "I thought I would never go back to the way I was before, my spirits were very low, I felt despondent, I thought everything was gone, that I had aged prematurely and that it would not change even though I had stopped

		doing drugs" (code: 78, a mixture of sport and exercise, young, inpatient, N/S)
Quality of life		
	The experience of increased quality of life is described by many as leading to recognition of the fact that a life free from drugs or alcohol will be a prerequisite for making their dreams work out in practice. (code: 75, structured fitness training, early middle-aged, outpatient, other)	
Social		
Perceived Social support	During the training period, participants enjoyed the social relations it involved, and many of them made it clear that recognition was a positive aspect of the training. (code: 75, structured fitness training, early middle-aged, outpatient, other)	"I've made some good mates, before this, I just f*****'sat in every day...all day. It was depressing, but now I've got something to look forward to, and I'm loads fitter." (Adam) (code:69, sports, young, outpatient, other) "Thanks for everything because if I didn't get put forward [signed up to the programme] with the heart and dedication and drive that is you, I wouldn't have met so many sound [nice] people. I've made some good mates, you know." (Stephen) (code:69, sports, young, outpatient, other)

Ten major themes emerged as unique benefits of exercise and sports intervention for the drug-depend groups. They are, “distraction”, “expressing true self”, “attaining a different kind of euphoria”, “establishing courage to face challenges”, “finding new purpose in life”, “establishing a disciplined lifestyle”, “improved communication skills”, “engaging with a supportive social network”, “having a supportive social space”, and “re-engage with community”. Table 10.2 illustrates exemplar quotes on each of the themes.

Table 10.2 Other benefits of exercise and sports intervention not captured by quantitative measures

Distraction	A mixture of leisure activities and exercise
	"... I nearly not swapped addictions but it just went from being obsessed about one thing to just being obsessed about f**king health and fitness like. (Participant 9, aged 24 years)" (code: 68, young, outpatient, voluntary treatment)
	"I think running that marathon at that time saved my life 'cause it was just a bad time in my life. It just gave me something to focus on, if you can do this, you can do f**king anything. It is achievement-like. (Participant 6, aged 25 years)" (code: 68, mixture of leisure activities and exercise, exercise only, young, outpatient, voluntary treatment)
	"I like it because I believe, I'm sure - although no one can be sure of nothing - but well, I think it's the only way for me to unwind. I often feel like I'm in a maze, and that's how I will get out of that maze. I love that very much, and I try to work out every day to sweat. It helps me to put my mind at ease, to get rid of my remorse, my obsessions, of the past, my guilt" Kyriakos. (code: 78, mixture of sport and exercise, young, inpatient, N/S)
	"For example, if I have an overwhelming day, exercise helps me clear my mind and forget about all the problems here and outside (Participant 2)." (code: 70, mixture of leisure activities and exercise, early middle-aged, N/S, N/S)
	Structured fitness training

Their thoughts move away from drugs or alcohol while they are carrying out other activities.[#]

(code: 75, structured fitness training, exercise only, early middle-aged, outpatient, other)

Sports

"If someone's into football... just... it clears your mind of everything else, or it does to me, when I'm on a football pitch I don't think of nowt else. And you feel good an' all, yeah good. Go home, have something to eat, feel better about... you're tired, it's good. But I love football, me. I'd play like every day, all the time if I could."

(code: 77, sports, young, exercise only, outpatient, voluntary treatment)

Expressing the true self

A mixture of sport and exercise

"What I have noticed, and in that I agree with the guys, is that in the court, one cannot easily "hide", that is, a lot of behaviours come out and people's true colours appear. In other words, what they say about the court being a mirror is true" Mike.

(code: 78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

"... I mean things that you may not take notice of during the day, and which do not come up in a conversation, you actually see them in the way someone plays, the way you play (pause) it is as if there are fewer filters in my behaviour, fewer, (pause) fewer blocks in my mind" Dimitris.

(code: 78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

"Now, going to the gym, well, I have tried to keep it up but find it hard. I don't know. (Pause) I think it is because we don't 'play' there. What I mean to say is that when we play basketball, there is all this action, joking around, besides exercising and having to follow a technique and all that. People's personalities come out, and so on. (Pause) the bottom line is that it seems to suit me more" Dimitris.

(code: 78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

"...we could get closer, much closer. (pause) it is harder to do so in a therapy group, what with your defences and fears, what with your worries about what to say. There are lots of different things that run through your head. During the workout, in the game, you show who you are and play, and that's it. it brings out the child in you, your spontaneity, it brings out everything. I think you're at your most innocent during the game. In other words, it brings out your true self" Asterix. (code: 78, mixture of sport and exercise, young, inpatient, N/S)

Attaining a different kind of " euphoria "

A mixture of sport and exercise

"Just being healthy and fit like, and just not being kinda [kind of] tied down with drink and drugs. I just felt so good like [smile], it gives you a high that you get off something. It is just feeling good, looking good and that kind of thing. (Participant 5, Male aged 23 years)"

(code: 68, mixture of leisure activities and exercise, exercise only, young, outpatient, voluntary treatment)

Structured fitness training

"You can get high working out on a bike"

(code: 75, structured fitness training, exercise only, early middle-aged, outpatient, other)

Establishing the courage to face challenges

Structured fitness training in combination with health education or psychotherapy

"Helped me face things I would normally have run away from, dealing with my life really. . .. (the course) pushes you out of your comfort zone. You get comfortable with being uncomfortable. (Joe, 35)."

(code:71, structured fitness training, Exercise sessions in combination with health education or psychotherapy, young, outpatient, voluntary treatment)

"The whole course makes you step up and deal with it. Speaking out and giving your opinion, pushing through that fear. (Nicole, 33)."

(code:71, structured fitness training, Exercise sessions in combination with health education or psychotherapy, young, outpatient, voluntary treatment)

Found new purpose in life

A mixture of sport and exercise

"It gave me my life back. More than anything, it gave me a purpose and to get to the other side of it. You get compulsive with it, you have to be training, and you are not training. It has gone the opposite way now. If I am not training now, you know no release and no release for anything. If I am training, everything is going well, and if I am not, there is something wrong. (Participant 6, aged 25 years)"

(code: 68, mixture of leisure activities and exercise, exercise only, young, outpatient, voluntary treatment)

Structured fitness training with health education or psychotherapy

"I am looking to do a degree. . . this course has pushed me in this direction, this has helped propel me, it fits. The understanding I gained about the community, throughout addiction, was all negative to the community, not that I am pushing."

(code:71, structured fitness training, Exercise sessions in combination with health education or psychotherapy, young, outpatient, voluntary treatment)

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Establishing a disciplined lifestyle

A mixture of leisure activities and exercise

".... It is kind of a discipline thing, you are asked to give you're all. (Participant 9, aged 24 years)"

(code: 68, mixture of leisure activities and exercise, exercise only, young, outpatient, voluntary treatment)

"The simple fact of getting up in the morning, starting the day, doing your shift... Everything, everything has improved (Participant 9)."

(code: 70, mixture of leisure activities and exercise, exercise only, early middle-aged, N/S, N/S)

Sport in combination with health education or psychotherapy

"It [the PLH programme] gets me out of bed this! I know it's 1 o'clock, but I don't go to bed until like 4 or 5 [am] most days. I don't know why. (Harry)"

(code:69, sports, Exercise sessions in combination with health education or psychotherapy, young, outpatient, other)

"I'd only sit around or get myself into trouble again if I wasn't coming here. (Adam)"

(code:69, sports, Exercise sessions in combination with health education or psychotherapy, young, outpatient, other)

Aerobic exercise in combination with health education or psychotherapy

"Instruction on how to exercise, as well as the exercise sessions, helped me with self-discipline."

(code: 74, aerobic exercises, Exercise sessions in combination with health education or psychotherapy, early middle-aged, inpatient, voluntary treatment)

Structured fitness training

They all say that it is good to have something to get up for since it also keeps them on the go from a purely physical point of view.[#]

(code: 75, structured fitness training, exercise only, early middle-aged, outpatient, other)

Improved communication skills

Structured fitness training in combination with health education or psychotherapy

"I find I listen an awful lot better, I hold back a lot more and just listen. I can interact with my kids a lot more, you know, when they are talking about stuff, rather than jump in, like they say, learn to listen and listen to learn. (Jason)." (code:71, structured fitness training, Exercise sessions in combination with health education or psychotherapy, young, outpatient, voluntary treatment)

“There is stuff that I have learned about family roles and that I am looking at other people’s point of view, and how it affected them rather than just about me because it is not just about me. It gives you a big insight into everything rather than just what you have been through or what you are going through. (Jason).”

(code:71, structured fitness training, Exercise sessions in combination with health education or psychotherapy, young, outpatient, voluntary treatment)

“It was tough. Stuff about families was tough, how kids take on different roles when parents are using. And I only ever saw my role, I never saw anyone else’s role, I never looked at my siblings as a product of the same environment–it was very painful, it was tough, I see them very differently now. (Emma).”

(code:71, structured fitness training, Exercise sessions in combination with health education or psychotherapy, young, outpatient, voluntary treatment)

A Mixture of sport and exercise

“People with communication issues have changed. And they have changed in general, not just about people they work out with, but also with people they don’t work out with. I can see that it is easier to approach them. The way I see it, he who takes care of his body opens up as a person.”

(code: 78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

It helped participants be more open, receptive and functional in the other treatment interventions.[#]

(code: 78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

“Yes, I joined the therapy groups in a better mood, and I am more open to giving more. Both to myself and to the rest of the group. That is, if I felt down in the dumps before a therapy session, I might have thought, «oh shit, I have to go to psychodrama now or ‘crap! It is psychotherapy time’ or ‘I feel pressured’. (Pause) it’s not as if I don’t feel pressured when I've worked out beforehand cause I do. And I realised a lot about myself. It helps me be more open and go with the flow” Mike.

(code: 78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

"... I notice the others talking to each other, making fun (pause), and I feel that I want to take part in it too, so (pause), I start to join in more" Mark.

(code: 78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

Exercise promoted integration into group and the cultivation of relations among patients. what's more, another dimension of it came to light, and the fact that it was mentioned by all participants without any prompt, indicates how strong its influence was. The "morning activity" was described as a process during which they could "let go" and be themselves.[#]

(code:78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

Structured fitness training in combination with health education or psychotherapy

"Completely different values, I learned my perception is not the only way, to come out of that and see someone else's point of view is a big change." (Emma, 46).

(code:71, structured fitness training, Exercise sessions in combination with health education or psychotherapy, young, outpatient, voluntary treatment)

Engaging with a supportive social network

A mixture of sport and exercise

"Good healthy friendships, the lads I go to the gym with are the lads that I go to AA meetings with. They are the same lads that call up for cups of tea and are the same lads that I go halves on my protein [sports supplements] with. So, if I ever stop going to the gym, I probably would lose friendships. The friends that I have got now, there is no paranoia. It is proper friendship. (Participant 9, aged 24 years)"

(code: 68, mixture of leisure activities and exercise, exercise only, young, outpatient, voluntary treatment)

"I want health and fitness too because it is a good way of getting to meet people on a personal level. Sport lets people get to know you and your personality without you getting embarrassed or making a show of yourself. (Participant 7, aged 25 years)"

(code: 68, mixture of leisure activities and exercise, exercise only, young, outpatient, voluntary treatment)

Aerobic exercise in combination with health education or psychotherapy

"Exercising together builds camaraderie and enhances social support."

(code: 74, aerobic exercises, Exercise sessions in combination with health education or psychotherapy, early middle-aged, inpatient, voluntary treatment)

Sports

"... the day after the tournament, three of them phoned us up and said 'we need you to come back' ... It was nice for them to... phone up and that. I do make a difference." (code: 77, sports, young, outpatient, voluntary treatment)

Gaining a supportive social space

A mixture of sport and exercise

Beyond the experience of strengthening exercise per se, another particular aspect emerged: the experience of the gym as an area, a place that favors communication, the bonding of patients and the cultivation of relations among them.[#]

(code: 78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

"In my view, it's not the weight lifting that makes a difference. I believe it's the gym, the place. (Pause) I use it as a place that suits me around here, which helps me to talk and also to listen" Marios.

(code: 78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

In some cases, being at the gym as an area seemed to outweigh the experience of doing strengthening exercises.[#]

(code: 78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

"I lift them (weights) every day, I do a few sets. (Pause) I stay at the gym for a couple of hours but I mostly talk to the other fellows of the center. I only really lift weights for fifteen to twenty minutes" Kyriakos.

(code: 78, mixture of sport and exercise, exercise only, young, inpatient, N/S)

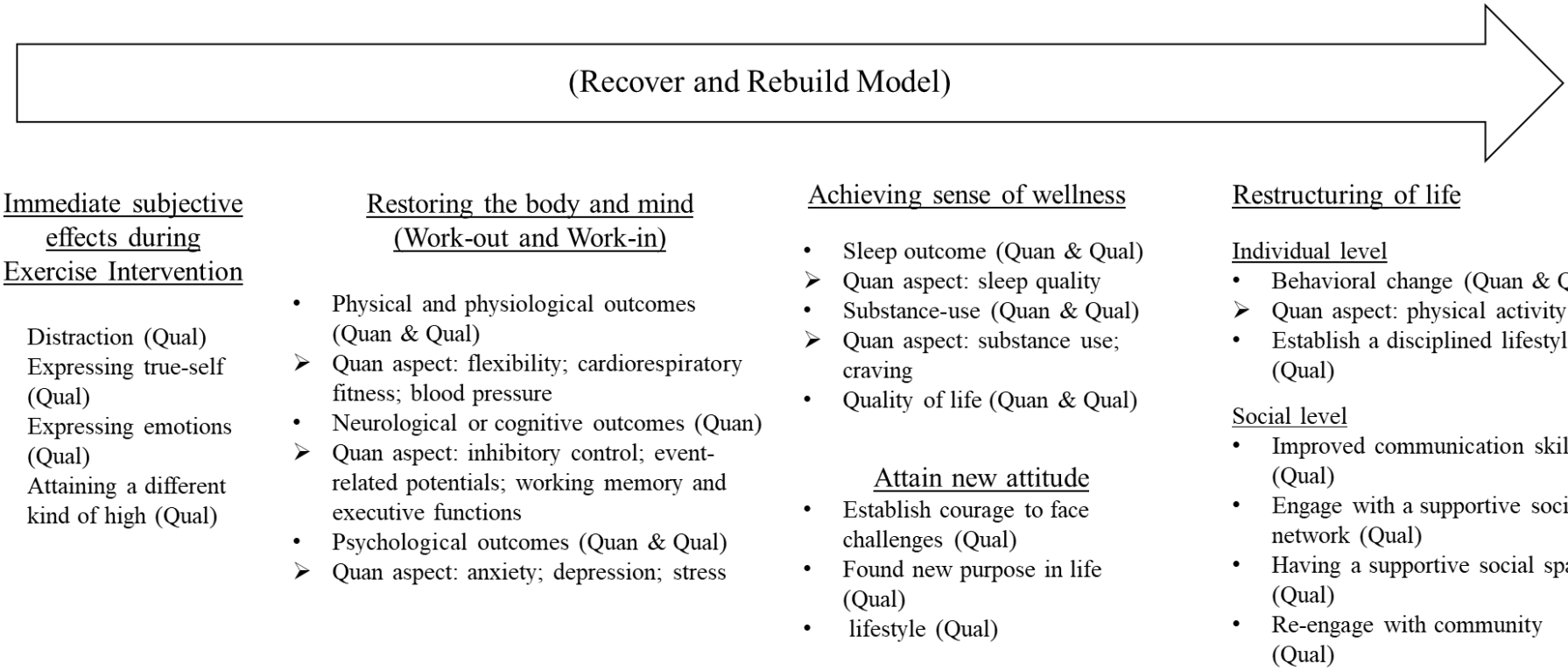
Re-engage with community

Structured fitness training in combination with health education or psychotherapy

"This course gave me a better understanding of the community, and drugs wreck every community. In my addiction, it was just about self, it was just about me, you wouldn't think about the impact and then getting accepted into my community–all I have ever put in was negative, with drug dealing and that, but to be accepted by my community and be putting something in that was positive, that was a big thing for me. (Jason)."

(code:71, structured fitness training, Exercise sessions in combination with health education or psychotherapy, young, outpatient, voluntary treatment)

Figure 17 Integrative understanding of the quantitative effects and qualitative benefits of the use of physical exercise as a treatment modality for the drug-dependent group



4. Discussion

The current research systematically reviewed, consolidated, and integrated evidence from quantitative, qualitative and mixed-method studies regarding the use of physical exercise as a treatment modality for the drug-dependent group in the treatment and rehabilitation phase. This section highlights key findings and discusses how these findings could provide practical insights and directions for practitioners and researchers taking into account the current situation and practice in Hong Kong. Specifically, the identification of the range of physical exercise interventions (Objective 1) and outcome measures (Objective 2) provides practitioners with a comprehensive reference on worldwide evidence-based practices. The synthesis of the effectiveness of different types of physical exercise intervention for two major subgroups (Objective 3); and recurring themes related to the subjective experiences of physical exercise intervention among the drug-dependent group (Objective 4) generates a model that improves our understanding on how physical exercise helps the drug-dependent group restore their bodily functions in the earlier stages, and helps them establish a new attitude and lifestyle through the experience. Finally, the social support gained from continuous physical exercise participation helps them re-engage with the community in the long-term.

The narrative summary of included studies found that most of the physical exercise interventions were conducted in China, followed by the United States. The majority of the interventions adopted a co-gender approach, with less than 30% of the studies adopting a gender-specific approach. When grouping the narrative summary according to the young adult subgroup and female subgroup, the top three most frequently investigated physical exercises for the young adult group were 1) aerobic exercise, 2) Mind-body exercise; and 3) structured fitness training. For the female group, the top three were 1) Mind-body exercise, 2)

aerobic exercise and 3) movement therapy. Although aerobic exercise was frequently investigated in both groups, the most frequently investigated aerobic exercise type for the young adult group was power cycling, and for the female subgroup, it was dancing. Yoga was the most frequently investigated type of mind-body exercise in both groups. The frequency of investigation reflects the current trend in the types of physical exercise that receive higher acceptability among specific groups. Practitioners in Hong Kong may refer to these trends when prescribing or selecting physical exercise for specific groups.

This review found that all the studies conducted among the Chinese population are experimental studies that only measure quantitative outcome measurements. Not a single article documents the subjective perceptions and views on the intervention among the drug-dependent group. There is a great need to learn about how drug-dependent group with Chinese ethnic and cultural backgrounds perceives physical exercise intervention and how it differs from their Western counterparts. This kind of qualitative investigation is much needed, as cultural factors always influence intervention effectiveness (Duran et al., 2004). In the future, qualitative or mix-method studies need to be conduct among the Chinese drug-dependent population to understand more how physical exercise helps different outcomes in the course of recovery.

The current review found that the three major types of physical exercise interventions being frequently investigated consistently showed significant positive effects on different health outcomes among the drug-dependent populations: mind-body exercise, aerobic exercise, and structured fitness training. In Hong Kong, according to the databases of funded projects by the Beat Drugs Fund (BDF) (data till 2020), the most frequently used physical exercise interventions are aerobic exercise (cycling activity) (Example: “WeCycle”; Project code: 20029, 170030, 150008, 130032) and structured fitness training (Example: “CROSS Fitness”; Project code: 180033, 160028), while yoga intervention was not as frequently

adopted; only one intervention was found till 2020 ("Mindfulness Training" Women-Focused Rehabilitation & After-care Project; Project code: 200036) (Supplementary file 1). Given its consistently significant effects in improving different health outcomes and its popularity among female, it is worthwhile for practitioners in Hong Kong to consider applying yoga intervention to the drug-dependent population in the future.

The literature review identified a total of 62 outcomes and 184 related instruments used to evaluate physical exercise interventions for the drug-dependent group. According to the project database of BDF, most of the physical exercise projects funded by BDF and conducted by NGOs used evaluation question sets provided by BDF in the homepage (https://www.nd.gov.hk/en/beat_questions_2010R2.html). These evaluation questions set mainly focus on attitude, knowledge and drug use. NGO tends to use these available questions set and did not measure other health outcomes. While these outcomes are important, practitioners in Hong Kong can also refer to the ten domains and respective outcome instruments identified in this research and measure these outcomes in the future.

Among the ten domains of outcomes, eight have sufficient primary studies to perform meta-analysis. Physical exercise as a treatment modality was found to be significantly better than control in improving outcomes related to physical, physiological, neurological, cognitive, psychological, behavioral, sleep, substance use and quality of life, but not pain. This suggests that if pain is a major issue faced by the drug-dependent group during treatment and rehabilitation, the use of physical exercise as a treatment modality may not be sufficient, and other treatment modalities are needed.

Since there were relatively few studies conducted among female drug-dependent population, only flexibility and quality of life outcomes allowed for sub-group meta-analysis. It was found that mind-body exercise was the only physical exercise type significantly better

than control groups in improving both outcomes. Based on the current evidence and its effectiveness in physical and quality of life outcomes, practitioners should prioritise mind-body exercise when treating female drug-dependent group.

Compared to the female drug-dependent group, the young adult group has a relatively number of primary studies that allow sub-group meta-analysis. Sub-group analyses were conducted on seven outcomes, cardiorespiratory fitness, blood pressure, anxiety, depression, physical activity, craving, and quality of life. It was consistently found that structured fitness training was significantly better than control groups in improving all outcomes except blood pressure. Similarly, aerobic exercise was consistently found to be significantly better than control groups in improving all the outcomes except physical activity and quality of life. As mentioned earlier, the physical exercise intervention project funded by BDF mainly focus on aerobic exercise and structured fitness training. This aligns with the literature, indicating that NGOs in Hong Kong should continue prescribing these two types of physical exercise to the young adult group, as there is strong evidence for their effectiveness.

Structured fitness training, mind-body exercise and a combination of leisure activity and exercise were the three types of physical exercise found to be significantly better than control groups in improving physical activity as a lifestyle behaviour outcome, this suggests that if the drug-dependent group aims for lifestyle change, these three types of exercise are superior to others. Practitioners may consider recommending these three types for long-term lifestyle change.

The meta-aggregation of qualitative data reveals unique benefits of exercise and sports intervention for the population that cannot be found in quantitative findings. It provides valuable insights into how physical exercise plays a role in different phases of

recovery, how specific physical exercise creates unique benefits, and how it contributes to helping the drug-dependent group to reintegrate into the community.

While the effectiveness of sport or a mixture of sport and exercise as treatment modality did not consistently change certain outcomes in quantitative studies, qualitative data revealed that sport or mixture of sport and exercise intervention helps drug-dependent group by providing a distraction from drugs or struggle in everyday life, allowing them to express their true selves during sports competition, and "attain a different kind of high". Coaches or health educators, and psychotherapists also assisted drug addicts in relating their participation in sport and exercise to their life experiences. Sport and exercise interventions help the drug-dependent group "establish courage to face challenges", "found new purpose in life", and "establish a disciplined lifestyle".

While quantitative evidence of improvement in social aspects was not strong, qualitative data reveals three themes related to the drug-dependent group's social well-being: "improved communication skills", "engaging with a supportive social network", and "having a supportive social space" and "re-engage with community". These qualitative themes provide practical implications to practitioners in the anti-drug sector. While physical exercise is seen as an effective treatment modality in improving different outcomes, the organization and long-term maintenance of physical exercise groups can help improve social support for the drug-dependent group. Enhanced social support is a key ingredient in helping the drug-dependent group re-engage with the community.

Strength

This study represents the first ever integrative synthesis that systematically identifies all types of physical exercise and outcome measures documented in the literature. It is also the first review to integrate qualitative and quantitative literature, generating a recovery and

rebuild model that illustrates the role and effects of physical exercise intervention in the trajectory of recovery for drug addicts. On top of these strengths, this review is the first review that incorporated articles published in both English and Chinese. All the included articles have been quality appraised using a standardized tool. Both English and Chinese literature contains articles with low, medium and high levels of quality. While most Western literature documented the use of yoga as a form of mind body exercise to complement drug treatment program, Chinese literature mostly used Health Qigong like Baduanjin in their treatment programme. Including articles published in Chinese has enriched the comprehensive investigation of the application of mindbody exercise as a treatment modality in this review.

Limitation

Although the BDF prioritizes the mother drug addict sub-group, a systematic literature search using keywords like "mother" or "pregnancy" did not yield any physical exercise studies that specifically investigating the effects of physical exercise among this sub-group. Additionally, most qualitative studies focus on the young adult sub-group, and not a single primary study extensively documents how female drug addicts perceive physical exercise intervention. The findings of this research may be biased towards the male and young adult groups and may not be fully represent the female population.

While there might be a hypothetical differential effect on the use of different types of physical exercise as treatment modality on drug dependent group who had taken different types of substances, such analysis is not possible as most articles/ investigations recruited participants with diverse substance use backgrounds. Currently, there are inadequate primary studies to perform subgroup analysis and draw a conclusion on the degree of usefulness

between the types of substances used and the type of physical exercises. If adequate primary studies are available, such investigation will be possible in the future.

5.Conclusion and Recommendation

To practitioner

1. Mind-body exercise, aerobic exercise and structured fitness training are the three major types of physical exercise most frequently investigated and consistently found to be significantly more effective than control groups in improving outcomes in the ten major domains. When prescribing physical exercise intervention for drug addicts, practitioner should give higher priority to these three.
2. Different exercise types have a different effect on different outcomes, if practitioners want to help drug addicts to improve specific outcomes, practitioner may refer to the subgroup analysis that the result section presented.
3. For female drug-dependent subgroup, mind-body exercise was consistently better than as compare with control in improving both quality of life and flexibility outcomes. Base on this evidence, practitioner may consider to give mind-body exercise a higher priority.
4. For young adult drug-dependent group, structured fitness, aerobic exercise, mind-body exercise and mixture of leisure activities and exercise are the four major types of physical exercise consistently found to be significantly more effective than control groups in improving several outcomes. Base on this evidence, practitioner may consider to give these exercise types a higher priority.
5. Coach or therapist can make use of the sport and exercise experience to help drug addicts to establish courage to face challenges in life. Debriefing session after sport or exercise session is important.

6. To facilitate drug addicts to re-integrate in community, NGO should organize physical/virtual social space and network that facilitate drug-dependent group to continuously engage in physical exercise with enhanced social support.

To researcher

1. Qualitative study on how drug addicts perceive physical exercise as treatment modality in their recovery trajectory is absent among the Chinese population. Future experimental study conducted in Hong Kong should consider mix-method study that capture data that cannot be measured quantitively.
2. All qualitative study focuses on the young adult group. Not even one qualitative study how female or mother drug addicts apply physical exercise modality in the rehabilitation process and how physical exercise play a role in the recover and community reintegration process. Future qualitative study should focus on female and the mother sub-group.
3. Most of the qualitative studies were not conducted with a clear qualitative inquiry framework, future qualitative studies should be guided by an explicit theory to improve the quality of the findings.
4. Future physical exercise intervention should either perform gender-based subgroup analysis or perform gender specific physical exercise intervention to help the rehabilitation sector to know more about which type of physical exercise is more superior than others in helping female drug addicts.
5. Both movement therapy and mind-body exercise were found to be significantly more effective than control groups in improving quality of life in both female and young adult subgroup. Given, there are currently only very few studies documenting the effectiveness of movement therapy, more investigation is needed in the future.

6. This research used meta-analysis that only allow pair-wise comparison, in the future network meta-analysis should be used to investigate the comparative effectives of different physical exercise modalities.

6.Observations and lessons learnt

When comparing the result from this review to anti-drug works conducted locally, it was found that what has been done locally is in line with the literature. Although a lot of good work has been done locally, the comprehensive literature search cannot find even one scholarly article from Hong Kong S.A.R. Most of the work related to physical exercise research in Hong Kong were service evaluation conducted by the anti-drug sector but not scholars. This might be the reason why there is a lack of data from Hong Kong in the literature.

7.Work of capacity building

The current project conducted four sessions of 2-hour seminar for healthcare-related undergraduate students, healthcare professionals, and professionals who work in drug treatment and rehabilitation. A total of 518 participants attended and 442 participants have full attendance. Over 70% of the participants gain knowledge about the use of physical exercise modalities for drug dependent group.

8. Appendix 1 Complete Search Strategy

MEDLINE (Ovid): From 1946 to September 2022

1. exp Substance-Related Disorders/ or Substance-Related Disorder*.mp.

2. exp Drug Overdose/ or Drug Overdos*.mp. or (exp Inhalant Abuse/ or Inhalant Abuse.mp.) or (exp Marijuana Abuse/ or Marijuana Abuse.mp.) or (exp Phencyclidine Abuse/ or Phencyclidine Abuse.mp.) or (exp Substance Abuse, Intravenous) or (exp Substance Abuse, Oral)

3. (chemical depend* or drug abuse* or drug addict* or drug depend* or drug habituation or "drug use disorder*" or “prescription drug abuse” or substance abuse* or substance addict* or substance depend* or "substance use*" or "substance use disorder*").mp.

4. exp Prescription Drug Misuse/ or Prescription Drug Misuse.mp.

5. exp Drug Misuse/ or Drug Misuse.mp. or (exp Prescription Drug Overuse/ or Prescription Drug Overuse.mp.)

6. (intravenous drug abuse or intravenous substance abuse or parenteral drug abuse).mp.

7. exp Adult/ or Adult*.mp.

8. exp Circuit-Based Exercise/ or Circuit-Based Exercise*.mp. or (exp Exercise/ or Exercise*.mp.) or (exp Exercise Movement Techniques/ or Exercise Movement Technique*.mp.) or (exp Plyometric Exercise/ or Plyometric Exercise*.mp.)

9. exp Endurance Training/ or Endurance Training.mp. or (exp High-Intensity Interval Training/ or High-Intensity Interval Training.mp.) or (exp Resistance Training/ or Resistance Training or circuit training).mp.

10. exp Gymnastics/ or Gymnastic*.mp. or (exp Muscle Stretching Exercises/ or Muscle Stretching Exercise*.mp.)

11. exp Breathing Exercises/ or Breathing Exercise*.mp. or (exp Dance Therapy/ or Dance Therap*.mp.) or (exp Tai Ji/ or Tai Ji.mp.) or (exp Yoga/ or Yoga.mp.) or (pilates based exercise* or pilates training).mp.

12. exp Sports/ or Sports.mp.

13. exp weight lifting/ or weight lifting*.mp.

14. exp Qigong/ or Qigong.mp. or (ch'i kung or qi gong).mp.

15. exp Running/ or Running.mp. or (exp Swimming/ or Swimming.mp.) or (exp Walking/ or Walking.mp.) or (acute exercise* or aerobic exercise* or exercise training* or isometric exercise* or physical activit* or physical exercise*).mp.

16. (t'ai chi or tai chi or tai chi chuan or tai ji quan or tai-ji or taiji or taijiquan).mp.

17. exp Mindfulness/ or Mindfulness.mp.

18. exp Mind-Body Therapies/ or Mind-Body Therap*.mp. or mind-body medicine*.mp.

19. 1 or 2 or 3 or 4 or 5 or 6

20. 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18

21. 7 and 19 and 20

22. Limited 21 to (full text and "review articles" and humans and yr="1946 -Current" and (chinese or english))

Note. *=truncation, exp=explode, mp=multi-purpose (searches several fields at once)

CINHAL complete: From 1946 to September 2022

1. MH Substance-Related Disorders OR MH Drug Overdose OR MH Inhalant Abuse OR MH Marijuana Abuse OR MH Phencyclidine Abuse OR MH Substance Abuse, Intravenous OR MH Substance Abuse, Oral OR MH Prescription Drug Misuse OR MH Drug Misuse OR MH Prescription Drug Overuse

2. TI Substance-Related Disorder* OR TI Drug Overdos* OR TI Inhalant Abuse OR TI Marijuana Abuse OR TI Phencyclidine Abuse

3. AB Substance-Related Disorder* OR AB Drug Overdos* OR AB Inhalant Abuse OR AB Marijuana Abuse OR AB Phencyclidine Abuse

4. TI ("chemical depend*") OR TI ("drug abuse*") OR TI ("drug addict*" or "drug depend*" or "drug habituation" or "drug use disorder*") OR TI ("prescription drug abuse") OR TI ("substance abuse*" or "substance addict*" or "substance depend*" OR TI ("substance use*" or "substance use disorder*")

5. AB ("chemical depend*") OR AB ("drug abuse*") OR AB ("drug addict*" or "drug depend*" or "drug habituation" or "drug use disorder*") OR AB ("prescription drug abuse*") OR AB ("substance abuse*" or "substance addict*" or "substance depend*") OR AB ("substance use*" or "substance use disorder*")

6. TI Prescription Drug Misuse OR TI Drug Misuse

7. AB Prescription Drug Misuse OR AB Drug Misuse

8. TI Prescription Drug Overuse

9. AB Prescription Drug Overuse

10. TI intravenous drug abuse OR TI intravenous substance abuse OR TI parenteral drug abuse

11. AB intravenous drug abuse OR AB intravenous substance abuse OR AB parenteral drug abuse

12. MH Adult

13. TI Adult*

14. AB Adult*

15. MH ("Circuit-Based Exercise" or "Exercise" or "Exercise Movement Techniques" or "Plyometric Exercise") OR MH ("Endurance Training" or "High-Intensity Interval Training" or "Resistance Training") OR MH ("Gymnastics" or "Muscle Stretching Exercises" or "Running" or "Swimming") OR MH ("Walking" or "Breathing Exercises" or "Dance Therapy" or "Tai Ji" or "Yoga" or "Sports" or "weight lifting" or "Qigong" or "Mindfulness" or "Mind-Body Therapies")

16. TI ("Circuit-Based Exercise*" or "Exercise*" or "Exercise Movement Technique*" or "Plyometric Exercise*" or "Endurance Training") OR TI ("High-Intensity Interval Training" or "Resistance Training") OR TI ("circuit training")

17. AB ("Circuit-Based Exercise*" or "Exercise*" or "Exercise Movement Technique*" or "Plyometric Exercise*" or "Endurance Training") OR AB ("High-Intensity Interval Training" or "Resistance Training") OR AB ("circuit training")

18. TI Gymnastic* OR TI Muscle Stretching Exercise*

19. AB Gymnastic* OR AB Muscle Stretching Exercise*

20. TI ("Running" or "Swimming" or "Walking" or "acute exercise*" or "aerobic exercise*") OR TI ("exercise training*") OR TI ("isometric exercise*") OR TI ("physical activit*" or "physical exercise*")

21. AB ("Running" or "Swimming" or "Walking" or "acute exercise*" or "aerobic exercise*") OR AB ("exercise training*") OR AB ("isometric exercise*") OR AB ("physical activit*" or "physical exercise*")

22. TI "Breathing Exercise*" or "Dance Therap*" or "Tai Ji" or "Yoga"

23. AB "Breathing Exercise*" or "Dance Therap*" or "Tai Ji" or "Yoga"

24. TI ("pilates training" or "pilates-based exercise*")

25. AB ("pilates training" or "pilates-based exercise*")

26. TI Sports

27. AB Sports

28. TI "weight lifting*"

29. AB "weight lifting*"

30. TI ("Qigong" or "ch'i kung" or "qi gong") OR TI ("t'ai chi" or "tai chi" or "tai chi chuan" or "tai ji quan" or "tai-ji" or "taiji" or "taijiquan")

31. AB ("Qigong" or "ch'i kung" or "qi gong") OR AB ("t'ai chi" or "tai chi" or "tai chi chuan" or "tai ji quan" or "tai-ji" or "taiji" or "taijiquan")

32. TI (Mindfulness or "Mind-Body Therap*" or "mind-body medicine*")

33. AB (Mindfulness or "Mind-Body Therap*" or "mind-body medicine*")

34. S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11

35. S12 OR S13 OR S14

36. S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33

37. S34 AND S35 AND S36

38. S37 Limiters - Full Text; Published Date: 19460101-20220931; Peer Reviewed; Research Article; Language: Chinese, English; Publication Type: Journal Article

Note. *=truncation, MH= Exact subject heading, TI= Title, AB= Abstract

Web of Science: From inception to September 2022

1. KP=(Substance-Related Disorders or Drug Overdose or Inhalant Abuse or Marijuana Abuse or Phencyclidine Abuse or Substance Abuse, Intravenous or Substance Abuse, Oral or Prescription Drug Misuse or Drug Misuse or Prescription Drug Overuse)

2. KP=(Adult)

3. KP=(Circuit-Based Exercise or Exercise or Exercise Movement Techniques or Plyometric Exercise or Endurance Training or High-Intensity Interval Training or Resistance Training or circuit-based exercise or Gymnastics or Muscle Stretching Exercises or Running or Swimming or Walking or Breathing Exercises or Dance Therapy or Tai Ji or Yoga or Sports or weight lifting or Qigong or Mindfulness or Mind-Body Therapies)

4. TI=(Substance-Related Disorder* or Drug Overdos* or Inhalant Abuse or Marijuana Abuse or Phencyclidine Abuse)

5. TI=(chemical depend* or drug abuse* or drug addict* or drug depend* or drug habituation or "drug use disorder" or “prescription drug abuse” or substance abuse* or substance addict* or substance depend* or "substance use*" or "substance use disorder*")

6. TI=(Prescription Drug Misuse or Drug Misuse)

7. TI=(Prescription Drug Overuse)

8. TI=(intravenous drug abuse or intravenous substance abuse or parenteral drug abuse)

9. TI=(Adult*)

10. TI=(Circuit-Based Exercise or Exercise or Exercise Movement Technique* or Plyometric Exercise* or Endurance Training or High-Intensity Interval Training or Resistance Training or circuit training)

11. TI=(Gymnastic* or Muscle Stretching Exercise*)

12. TI=(Running or Swimming or Walking or acute exercise* or aerobic exercise *or exercise training* or isometric exercise* or physical activit* or physical exercise*)

13. TI=(Breathing Exercise* or Dance Therap* or Tai Ji or Yoga)

14. TI=(pilates based exercise* or pilates training)

15. TI=(Sports)

16. TI=(weight lifting*)

17. TI=(Qigong or ch'i kung or qi gong or t'ai chi or tai chi or tai chi chuan or tai ji quan or tai-ji or taiji or taijiquan)

18. TI=(Mindfulness or Mind-Body Therap* or mind body medicine*)

19. AB=(Substance-Related Disorder* or Drug Overdos* or Inhalant Abuse or Marijuana Abuse or Phencyclidine Abuse)

20. AB=(chemical depend* or drug abuse* or drug addict* or drug depend* or drug habituation or "drug use disorder*" or “prescription drug abuse” or substance abuse* or substance addict* or substance depend* or "substance use*" or "substance use disorder*")

21. AB=(Prescription Drug Misuse or Drug Misuse)

22. AB=(Prescription Drug Overuse)

23. AB=(intravenous drug abuse or intravenous substance abuse or parenteral drug abuse)

24. AB=(Adult*)

25. AB=(Circuit-Based Exercise* or Exercise* or Exercise Movement Technique* or Endurance Training or High-Intensity Interval Training or Resistance Training or circuit training)

26. AB=(Gymnastic* or Muscle Stretching Exercise*)

27. AB=(Running or Swimming or Walking or acute exercise* or aerobic exercise* or exercise training* or isometric exercise* or physical activit* or physical exercise*)

28. AB=(Breathing Exercise* or Dance Therap* or Tai Ji or Yoga)

29. AB=(pilates based exercise* or pilates training)

30. AB=(Sports)

31. AB=(weight lifting*)

32. AB=(Qigong or ch'i kung or qi gong or t'ai chi or tai chi or tai chi chuan or tai ji quan or tai-ji or taiji or taijiquan)

33. AB=(Mindfulness or Mind-Body Therap* or mind body medicine*)

34. #1 OR #4 OR #5 OR #6 OR #7 OR #8 OR #19 OR #20 OR #21 OR #22 OR #23

35. #2 OR #9 OR #24

36. #3 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33

37. #34 AND #35 AND #36

38. #34 AND #35 AND #36 and Review Article (Document Types) and 2022 or 2021 or 2020 or 2019 or 2018 or 2017 or 2016 or 2015 or 2014 or 2013 or 2012 or 2011 or 2010 or 2009 or 2008 or 2007 or 2006 or 2005 or 2004 or 2003 or 2002 or 2001 or 2000 or 1999 or 1998 or 1997 or 1996 or 1995 or 1994 or 1993 or 1992 or 1991 (Publication Years) and Review Article (Document Types) and English (Languages)

Note. *=truncation, KP= keyword plus, TI= Title, AB= Abstract

Scopus: From inception to September 2022

1. (TITLE-ABS-KEY ("Substance-Related Disorder*" OR "Drug Overdos*" OR "Inhalant Abuse" OR "Marijuana Abuse" OR "Phencyclidine Abuse") OR TITLE-ABS-KEY ("chemical depend*" OR "drug abuse" OR "drug addict*" OR "drug depend*" OR "drug habituation" OR "drug use disorder*" OR "prescription drug abuse" OR "substance abuse*" OR "substance addict*" OR "substance depend*") OR TITLE-ABS-KEY ("Substance use*" OR "Prescription Drug Misuse") OR TITLE-ABS-KEY ("Drug Misuse" OR "Prescription Drug Overuse" OR "intravenous drug abuse" OR "intravenous substance abuse" OR "parenteral drug abuse"))

2. TITLE-ABS-KEY (adult*)

3. TITLE-ABS-KEY ("Circuit-Based Exercise" OR "Exercise*" OR "Exercise Movement Technique*" OR "Plyometric Exercise" OR "Endurance Training" OR "High-Intensity Interval Training" OR "Resistance Training" OR "circuit training" OR "Gymnastic*" OR "Muscle Stretching Exercise*" OR "Running" OR "Swimming" OR "Walking" OR "acute exercise*" OR "aerobic exercise*" OR "exercise training*" OR "isometric exercise*" OR "physical activit*" OR "physical exercise*" OR "Breathing Exercise*" OR "Dance Therap*" OR "Tai Ji" OR "Yoga" OR "pilates training" OR "pilates-based exercise*" OR "Sports" OR "weight lifting*" OR "Qigong" OR "ch'i kung" OR "qi gong" OR "t'ai chi" OR "tai chi" OR "tai chi chuan" OR "tai ji quan" OR "tai-ji" OR "taiji" OR "taijiquan" OR "Mindfulness" OR "Mind-Body Therap*" OR "mind-body medicine*")

4. #3 AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Chinese")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (EXACTKEYWORD , "Adult"))

Note. *= truncation, TITLE-ABS-KEY= title, abstract, and keywords

Physiotherapy Evidence Database (PEDro): From inception to September 2022

Substance-Related Disorders OR Drug Overdose OR Inhalant Abuse OR Marijuana Abuse OR Phencyclidine Abuse OR Intravenous Substance Abuse OR Oral Substance Abuse OR

drug abuse OR prescription drug abuse OR substance abuse OR drug addiction OR substance addiction OR chemical dependence OR Drug dependence OR substance dependence OR Drug use disorder OR substance related disorder OR substance use disorder OR drug habituation OR substance addiction OR substance use OR substance use disorder OR substance uses OR Prescription Drug Misuse OR Drug Misuse OR Prescription Drug Overuse OR intravenous drug abuse OR parenteral drug abuse

China Network Knowledge Infrastructure (CNKI): From inception to September 2022

SU=('物質濫用'+'藥物習慣'+'吸毒'+'處方藥濫用'+'藥物成癮'+'藥物依賴'+'藥物濫用'+'物質依賴'+'吸毒成癮'+'物質相關障礙'+'處方藥濫用'+'濫用'+'靜脈藥物濫用'+'毒品')*('成年人'+'成年')*('運動療法'+'運動治療'+'運動'+'體力活動'+'急性運動'+'有氧運動'+'無氧運動'+'低氧運動'+'運動訓練'+'運動技巧'+'柔韌性運動'+'運動活動'+'活動'+'阻力訓練'+'耐力訓練'+'訓練'+'高強度間歇訓練'+'運動'+'體育'+'體操'+'舉重'+'瑜伽'+'氣功'+'太極拳'+'太極'+'正念鍛煉'+'正念療法'+'正念'+'伸展運動'+'普拉提運動'+'普拉提斯運動'+'彼拉提斯運動'+'普拉提訓練'+'身心療法'+'舞蹈治療'+'舞蹈動作治療'+'舞蹈心理治療')

Note. SU = subject heading

9. Appendix 2 References with code

Code	APA 7th
1	Colledge, F., Vogel, M., Dürsteler-Macfarland, K., Strom, J., Schoen, S., Pühse, U., & Gerber, M. (2017). A pilot randomized trial of exercise as adjunct therapy in a heroin-assisted treatment setting. *Journal of Substance Abuse Treatment*, *76*, 49–57. https://doi.org/10.1016/j.jsat.2017.01.012
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10. Appendix 3 Complete Search Strategy

MEDLINE (Ovid): From 1946 to January 2023

1. exp Substance-Related Disorders/ or Substance-Related Disorder*.mp.

2. exp Drug Overdose/ or Drug Overdos*.mp. or (exp Inhalant Abuse/ or Inhalant Abuse.mp.) or (exp Marijuana Abuse/ or Marijuana Abuse.mp.) or (exp Phencyclidine Abuse/ or Phencyclidine Abuse.mp.) or exp Substance Abuse, Intravenous/ or exp Substance Abuse, Oral/

3. exp Prescription Drug Misuse/ or Prescription Drug Misuse.mp.

4. (chemical depend* or drug abuse* or drug addict* or drug depend* or drug habituation).mp.

5. ("drug use disorder" or "prescription drug abuse" or "substance abuse").mp.

6. (substance addict* or substance depend* or "substance use*" or "substance use disorder*").mp.

7. exp Drug Misuse/ or Drug Misuse.mp. or (exp Prescription Drug Overuse/ or Prescription Drug Overuse.mp.)

8. (intravenous drug abuse or intravenous substance abuse or parenteral drug abuse).mp.

9. exp Adult/ or Adult*.mp.

10. exp Mothers/ or Mothers.mp.

11. exp Circuit-Based Exercise/ or Circuit-Based Exercise*.mp. or (exp Exercise/ or Exercise*.mp.) or (exp Exercise Movement Techniques/ or Exercise Movement Technique*.mp.) or (exp Plyometric Exercise/ or Plyometric Exercise*.mp.)

12. exp Endurance Training/ or Endurance Training.mp.

13. exp High-Intensity Interval Training/ or High-Intensity Interval Training.mp.

14. exp Resistance Training/ or Resistance Training.mp. or circuit training.mp.

15. exp Gymnastics/ or Gymnastic*.mp. or (exp Muscle Stretching Exercises/ or Muscle Stretching Exercise*.mp.)

16. exp Breathing Exercises/ or Breathing Exercise*.mp. or (exp Dance Therapy/ or Dance Therap*.mp.) or (exp Tai Ji/ or Tai Ji.mp.) or (exp Yoga/ or Yoga.mp.) or (pilates based exercise* or pilates training).mp.

17. exp Sports/ or Sports.mp.

18. exp weight lifting/ or weight lifting*.mp.

19. exp Qigong/ or Qigong.mp. or (ch'i kung or qi gong).mp.

20. exp Running/ or Running.mp. or (exp Swimming/ or Swimming.mp.) or (exp Walking/ or Walking.mp.) or (acute exercise* or aerobic exercise* or exercise training* or isometric exercise* or physical activit* or physical exercise*).mp.

21. (t'ai chi or tai chi or tai chi chuan or tai ji quan or tai-ji or taiji or taijiquan).mp.

22. exp Mindfulness/ or Mindfulness.mp.

23. exp Mind-Body Therapies/ or Mind-Body Therap*.mp. or mind-body medicine*.mp.

24. exp Grounded Theory/ or Grounded Theory.mp. or (exp qualitative research/ or qualitative research.mp.) or (exp Hermeneutics/ or Hermeneutics.mp.) or (exp Interview/ or Interview.mp.) or (exp Personal Narrative/ or Personal Narrative.mp.) or (exp Empirical Research/ or Empirical Research.mp.) or Document Analysis.mp.

25. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8

26. 9 or 10

27. 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23

28. 24 and 25 and 26 and 27

29. limit 28 to (full text and humans and yr="1946 -Current" and (chinese or english))

Note. *=truncation, exp=explode, mp=multi-purpose (searches several fields at once)

CINHAL complete: From 1946 to January 2023

1. MH Substance-Related Disorders OR MH Drug Overdose OR MH Inhalant Abuse OR MH Marijuana Abuse OR MH Phencyclidine Abuse OR MH Substance Abuse, Intravenous OR MH Substance Abuse, Oral OR MH Prescription Drug Misuse OR MH Drug Misuse OR MH Prescription Drug Overuse

2. TI Substance-Related Disorder* OR TI Drug Overdos* OR TI Inhalant Abuse OR TI Marijuana Abuse OR TI Phencyclidine Abuse

3. AB Substance-Related Disorder* OR AB Drug Overdos* OR AB Inhalant Abuse OR AB Marijuana Abuse OR AB Phencyclidine Abuse

4. TI ("chemical depend*") OR TI ("drug abuse*") OR TI ("drug addict*" or "drug depend*" or "drug habituation" or "drug use disorder*") OR TI ("prescription drug abuse") OR TI ("substance abuse*" or "substance addict*" or "substance depend*" OR TI ("substance use*" or "substance use disorder*")

5. AB ("chemical depend*") OR AB ("drug abuse*") OR AB ("drug addict*" or "drug depend*" or "drug habituation" or "drug use disorder*") OR AB ("prescription drug abuse*") OR AB ("substance abuse*" or "substance addict*" or "substance depend*") OR AB ("substance use*" or "substance use disorder*")

6. TI Prescription Drug Misuse OR TI Drug Misuse

7. AB Prescription Drug Misuse OR AB Drug Misuse

8. TI Prescription Drug Overuse

9. AB Prescription Drug Overuse

10. TI intravenous drug abuse OR TI intravenous substance abuse OR TI parenteral drug abuse

11. AB intravenous drug abuse OR AB intravenous substance abuse OR AB parenteral drug abuse

12. MH Adult

13. TI Adult*

14. AB Adult*

15. MH mothers

16. AB Mother*

17. TI Mother*

18. MH ("Circuit-Based Exercise" or "Exercise" or "Exercise Movement Techniques" or "Plyometric Exercise") OR MH ("Endurance Training" or "High-Intensity Interval Training" or "Resistance Training") OR MH ("Gymnastics" or "Muscle Stretching Exercises" or "Running" or "Swimming") OR MH ("Walking" or "Breathing Exercises" or "Dance Therapy" or "Tai Ji" or "Yoga" or "Sports" or "weight lifting" or "Qigong" or "Mindfulness" or "Mind-Body Therapies")

19. TI ("Circuit-Based Exercise*" or "Exercise*" or "Exercise Movement Technique*" or "Plyometric Exercise*" or "Endurance Training") OR TI ("High-Intensity Interval Training" or "Resistance Training") OR TI ("circuit training")

20. AB ("Circuit-Based Exercise*" or "Exercise*" or "Exercise Movement Technique*" or "Plyometric Exercise*" or "Endurance Training") OR AB ("High-Intensity Interval Training" or "Resistance Training") OR AB ("circuit training")

21. TI Gymnastic* OR TI Muscle Stretching Exercise*

22. AB Gymnastic* OR AB Muscle Stretching Exercise*

23. TI ("Running" or "Swimming" or "Walking" or "acute exercise*" or "aerobic exercise*") OR TI ("exercise training*") OR TI ("isometric exercise*") OR TI ("physical activit*" or "physical exercise*")

24. AB ("Running" or "Swimming" or "Walking" or "acute exercise*" or "aerobic exercise*") OR AB ("exercise training*") OR AB ("isometric exercise*") OR AB ("physical activit*" or "physical exercise*")

25. TI "Breathing Exercise*" or "Dance Therap*" or "Tai Ji" or "Yoga"

26. AB "Breathing Exercise*" or "Dance Therap*" or "Tai Ji" or "Yoga"

27. TI ("pilates training" or "pilates-based exercise*")

28. AB ("pilates training" or "pilates-based exercise*")

29. TI Sports

30. AB Sports

31. TI "weight lifting*"

32. AB "weight lifting*"

33. TI ("Qigong" or "ch'i kung" or "qi gong") OR TI ("t'ai chi" or "tai chi" or "tai chi chuan" or "tai ji quan" or "tai-ji" or "taiji" or "taijiquan")

34. AB ("Qigong" or "ch'i kung" or "qi gong") OR AB ("t'ai chi" or "tai chi" or "tai chi chuan" or "tai ji quan" or "tai-ji" or "taiji" or "taijiquan")

35. TI (Mindfulness or "Mind-Body Therap*" or "mind-body medicine*")

36. AB (Mindfulness or "Mind-Body Therap*" or "mind-body medicine*")

37. TI (Grounded Theory or qualitative research or Hermeneutics or Interview or Personal Narrative or Empirical Research or Document Analysis)

38. AB (Grounded Theory or qualitative research or Hermeneutics or Interview or Personal Narrative or Empirical Research or Document Analysis)

39. S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11

40. (S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11) AND (S12 OR S13 OR S14 OR S15 OR S16 OR S17)

41. ((S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11) AND (S12 OR S13 OR S14 OR S15 OR S16 OR S17)) AND (S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36)

42. S37 OR S38

43. (S37 OR S38) AND (S41 AND S42)

44. S43 Limiters - Full Text; Published Date: 19460101- 20211231; Peer Reviewed; Research Article; Language: Chinese, English; Publication Type: Journal Article

Note. *=truncation, MH= Exact subject heading, TI= Title, AB= Abstract

Web of Science: From inception to January 2023

1. KP=(Substance-Related Disorders)) OR KP=(Drug Overdose))) OR KP=(Inhalant Abuse)) OR KP=(Marijuana Abuse))) OR KP=(Substance Abuse, Intravenous)) OR KP=(Phencyclidine Abuse)) OR KP=(Substance Abuse, Oral)) OR KP=(Prescription Drug Misuse)) OR KP=(Drug Misuse)) OR KP=(Prescription Drug Overuse)

2. KP=(Adult)

3. KP=(Mother OR Mother*)

4. KP=(Circuit-Based Exercise or Exercise or Exercise Movement Techniques or Plyometric Exercise or Endurance Training or High-Intensity Interval Training or Resistance Training or circuit-based exercise or Gymnastics or Muscle Stretching Exercises or Running or Swimming or Walking or Breathing Exercises or Dance Therapy or Tai Ji or Yoga or Sports or weight lifting or Qigong or Mindfulness or Mind-Body Therapies)

5. KP=(Grounded Theory or qualitative research or Hermeneutics or Interview or Personal Narrative or Empirical Research or Document Analysis)

6. TI=(Substance-Related Disorders or Drug Overdose or Inhalant Abuse or Marijuana Abuse or Phencyclidine Abuse or Substance Abuse, Intravenous or Substance Abuse, Oral or Prescription Drug Misuse or Drug Misuse or Prescription Drug Overuse)

7. TI=(Adult or Adults)

8. TI=(Mother OR Mother*)

9. TI=(circuit-Based Exercise or Exercise or Exercise Movement Techniques or Plyometric Exercise or Endurance Training or High-Intensity Interval Training or Resistance Training or circuit-based exercise or Gymnastics or Muscle Stretching Exercises or Running or Swimming or Walking or Breathing Exercises or Dance Therapy or Tai Ji or Yoga or Sports or weight lifting or Qigong or Mindfulness or Mind-Body Therapies)

10. TI=(Grounded Theory or qualitative research or Hermeneutics or Interview or Personal Narrative or Empirical Research or Document Analysis)

11. AB=(Substance-Related Disorders or Drug Overdose or Inhalant Abuse or Marijuana Abuse or Phencyclidine Abuse or Substance Abuse, Intravenous or Substance Abuse, Oral or Prescription Drug Misuse or Drug Misuse or Prescription Drug Overuse)

12. AB=(Adult or Adults)

13. AB=(Mother OR Mother*)

14. AB=(circuit-Based Exercise or Exercise or Exercise Movement Techniques or Plyometric Exercise or Endurance Training or High-Intensity Interval Training or Resistance Training or circuit-based exercise or Gymnastics or Muscle Stretching Exercises or Running or Swimming or Walking or Breathing Exercises or Dance Therapy or Tai Ji or Yoga or Sports or weight lifting or Qigong or Mindfulness or Mind-Body Therapies)

15. AB=(Grounded Theory or qualitative research or Hermeneutics or Interview or Personal Narrative or Empirical Research or Document Analysis)

16. #1 OR #6 OR #11

17. #2 OR #3 OR #7 OR #8 OR #12 OR #13

18. #4 OR #9 OR #14

19. #5 OR #10 OR #15

20. #16 AND #17 AND #18 AND #19 and English (Languages)

Note. *=truncation, KP= keyword plus, TI= Title, AB= Abstract

Scopus: From inception to January 2023

(TITLE-ABS-KEY ("Substance-Related Disorder*" OR "Drug Overdos*" OR "Inhalant Abuse" OR "Marijuana Abuse" OR "Phencyclidine Abuse") OR TITLE-ABS-KEY ("chemical depend*" OR "drug abuse" OR "drug addict*" OR "drug depend*" OR "drug habituation" OR "drug use disorder*" OR "prescription drug abuse" OR "substance abuse*" OR "substance addict*" OR "substance depend*") OR TITLE-ABS-KEY ("Substance use*" OR "Prescription Drug Misuse") OR TITLE-ABS-KEY ("Drug Misuse" OR "Prescription Drug Overuse" OR "intravenous drug abuse" OR "intravenous substance abuse" OR "parenteral drug abuse")) AND TITLE-ABS-KEY ("adult*" OR "mother" OR "mothers") AND TITLE-ABS-KEY ("Circuit-Based Exercise" OR "Exercise*" OR "Exercise Movement Technique*" OR "Plyometric Exercise" OR "Endurance Training" OR "High-Intensity Interval Training" OR "Resistance Training" OR "circuit training" OR "Gymnastic*" OR "Muscle Stretching Exercise*" OR "Running" OR "Swimming" OR "Walking" OR "acute exercise*" OR "aerobic exercise*" OR "exercise training*" OR "isometric exercise*" OR "physical activit*" OR "physical exercise*" OR "Breathing Exercise*" OR "Dance Therap*" OR "Tai Ji" OR "Yoga" OR "pilates training" OR "pilates-based exercise*" OR "Sports" OR "weight lifting*" OR "Qigong" OR "ch'i kung" OR "qi gong" OR "t'ai chi" OR "tai chi" OR "tai chi chuan" OR "tai ji quan" OR "tai-ji" OR "taiji" OR "taijiquan" OR "Mindfulness" OR "Mind-Body Therap*" OR "mind-body medicine*") AND TITLE-ABS-KEY ("Grounded Theory" OR "qualitative research" OR "Hermeneutics" OR "Interview" OR "Personal Narrative" OR "Empirical Research" OR "Document Analysis")

Note. *= truncation, TITLE-ABS-KEY= title, abstract, and keywords

11.Supplementary file 1

No.	Year	Project title& no.	Gender & Age	Target group	Physical exercise modalities
1	2020	WeCycle IV (200029)	Both; NS	DB	Bike training
2	2020	Mindfulness Training: Women-Focused Rehabilitation & After-care Project (200036)	Female: NS	DR	Yoga training
3	2019	"Project EMpower" – Ethnic Minority Youth Enhancement Scheme (190019)	Both; 12-24	DB	Fitness
4	2018	CROSS Fitness 2.0 – A Community-Based Reintegrated Project for Young Adult with Drug Abuse (180033)	Both; Youth	DB	Exercise-based intervention
5	2018	Enlightening Hope – Strengthening Rehabilitation and Aftercare Services Programme (180030)	Both; NS	DR	Sports competition Interest Class
6	2017	Wecycle III (170030)	Both; NS	DB	Bike training
7	2017	VR Station (170032)	Both; Youth	DB	VR sports training
8	2017	Healthy Life Style for LGBT Youths (170035)	Both; NS	DB	Sports and fitness courses
9	2016	Sports Challenge - anti-drug social network development project (160025)	Both; Youth	DB	Sport activities (Gym-based fitness Training and sport competition)
10	2016	CROSS Fitness - a community-based rehabilitation project (160028)	Both; NS	DB	Exercise-based intervention (Trendy sport activities like kick-boxing, yoga, kinball, hiking)
11	2015	We-Cycle II (150008)	Both; NS	DB	Bike training
12	2013	We-Cycle (130032)	Both; NS	DB	Bike training, physical fitness
13	2012	Sports Clinic – "KICK" Drug Out! (120019)	Both; NS	DR	Aerobic kickboxing/fitball/Pilates/Relaxation & Stretching

Remarks: NS = Non-specific; DB = Drug abuser; DR= Drug rehabilitees

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